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|  | RENEWABLE ENERGY TEST CENTRE, MURTHAL |  |
| | DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE & TECHNOLOGY | |
| | Regional Testing Centre <i>Solar Thermal Energy Devices Testing & Technical Backup unit centre and Research Facility for Solar Thermal System approved by Ministry of New & Renewable Energy (MNRE), Govt. of India & National Accreditation Board for Testing and Calibration Laboratory (NABL)</i> | |

No. RETC/ 132

Date 27/12/22

To

M/s Shri Badrinath Vaikalpik Urja Ltd.
Daudwala, Post office – Mothrowala
Dehradun – 248001 (Uttarakhand)

Subject: Testing of Evacuated Tube collector (ETC 500 LPD) Submitted by you.

Dear Sir,

I am enclosing herewith testing report of Evacuated Tube collector (ETC 500 LPD) based Hot Water System submitted by you, bearing Report No RETC/RTC/ETC/54/2022. Kindly collect your system within 30 days of the issue of this report from RTC, Murthal. The centre will not be responsible for the system after the mentioned days.

Thanking you.

Yours Sincerely

Jam
27/12/2022
Authorized Signatory
Regional Testing Centre

Centre of Excellence for Renewable Energy Test Centre (RETC),
Deenbandhu Chhotu Ram University of Science & Technology
Murthal, Sonapat-131035, Hariana



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No. - RETC/TR/ETC/03 Page No. 01/09

Test Report No. TC85712200000055F Service Request No: RETC/RTC/ETC/54/2022

TEST REPORT OF ALL GLASS EVACUATED TUBE SOLAR WATER HEATING SYSTEM AS PER IS 16544:2016

Discipline - Mechanical

Group - Thermal Tests

Date of Issue of Test Report: 27.12.2022

Table with 3 columns: A. GENERAL, B. SPECIFICATION OF THE TEST SAMPLE, and detailed test parameters like Name & Address of manufacturer, Contact details, Date of Receipt, etc.

Technical Manager (Ravi)

Quality Manager (Dheeraj Yadav)

Authorized Signatory (Prof. Rajni Shukla) Regional Testing Centre Centre of Excellence for Renewable Energy Test Centre (RETC) Deenbandhu Chhotu Ram University of Science & Technology Murthal, Sonapat-131039 Haridvara



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| | | | |
|----|---|---|----------------------|
| i | Exposed area (gross) of a single tube (Di L), m ² | 0.275 | |
| j | Gross Aperture Area of the collector, m ² | 5.50 | |
| k | Reflector below the tubes (provided/not provided) | Not Provided | |
| 2 | Storage Tank | | |
| a. | Dimensions <ul style="list-style-type: none">Inner Tank Thickness and MaterialMaterial and thickness of outer Cladding | 1.613 mm, Graphene Coating Pre Coated Galaluminium, 0.450 mm | |
| b. | Capacity (kg) (without taking into account water in the collector) | 500 Ltrs. | |
| c. | Specifications/Tests | Specified Requirements | Results |
| | Material and Thickness of Insulation <ul style="list-style-type: none">Plane side of TankCircular side of Tank | As per IS 16542:2016 cl no. 5.3 ≥ 50 mm ≥ 50 mm | 50.00 mm 50.00 mm |
| d. | Height of Hot water withdrawal point from bottom of the tank | 1522 mm | |
| e. | Height of cold water inlet point from bottom of the tank | 860 mm | |
| f. | Any other Information | NA | |
| 3 | Connecting Pipes | | |
| a. | Material | *Seamless pipe (Mild Steel) | |
| b. | Outer/Inner Diameter | 30.9 mm/ 25.2 mm | |
| c. | Outer surface Coating | Graphene Coating | |
| d. | Insulation Material and Thickness | NA | |
| 4 | Supported stand/frame | | |
| a. | Material | Galvanized Iron | |
| b. | Type and thickness | 1.220 mm | |
| c. | Outer surface coating | Pure Polyester Powder Coating | |

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(Dheeraj Yadav)

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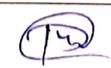
TC-8571

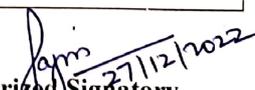
Test Report No. TC857122000000055F

Page No. 03/09

| C | Test results | | |
|----|---|-----------------------------|-------------------------------|
| 1. | Pre-conditioning test | | |
| | A result of inspection after 15 days of Pre-conditioning test. | Satisfactory/Unsatisfactory | Satisfactory |
| 2. | Static pressure leakage test | | |
| a | Initial & final pressure (kg/cm ²) | | 0.2 kg/cm ² |
| b | Temperature of water in the storage tank (°C) | | 60°C |
| c | Duration of the test period (min.) | | 30 minutes |
| d | Results of inspection | | Leakage is not observed |
| 3. | Thermal performance test | | |
| a | %age maximum efficiency of the system , $\eta_{sys, d}$ | | 0.62 |
| b | Overall heat loss coefficient of the system during day time test, $U_{sys, d}$ (W/m ² K) | | 3.59 |
| c | Night time heat loss coefficient of the system, $U_{sys, n}$ (W/m ² K) and $\tau_{cooling, n}$ (days) i.e. < 2 W/(m ² °C) | | 1.97 |
| d | Percentage system efficiency at standard test conditions $T_s = 50^\circ\text{C}$, $T_{ad} = 25^\circ\text{C}$, $G_T = 700 \text{ W/m}^2$ | | 0.51 |
| e | Average amount of energy collected (Q) during the period of day time test corresponding to standard test conditions (Kwh) | | 13.74 |
| f | A table of the data points for day time test along with values of wind speed (Averaged over a period of 30 minutes) during the test. | | (Please See Page No. – 05/09) |
| g | A graph between X & η_{sys} | | (Please See Page No. – 08/09) |
| 4 | Any other details - NO | | |
| 5 | Remarks: Overall performance of the system is satisfactory. | | |


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Regional Testing Centre

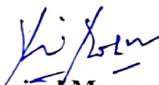
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Murthal, Sonapat-131035, Haryana

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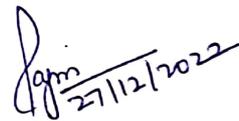
Test Report No. TC85712200000055F

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1. This report in full or in part may not be published or advertised or used for any legal action unless prior permission has been secured from this test centre
2. This test report refers only to the specimen supplied.
3. This results presented here relate only to the conditions of the measurement at the time of testing.
4. Any queries or suggestion related to retesting will be entertained till one month of receipt of this report.
5. * Indicates the data provided by customer/manufacturer.


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 (Ravi)


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 (Dheeraj Yadav)


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Test Report No. TC85712200000055F

Page No. 05/09

Solar Evacuated Tube Collector Thermal Performance Test

Manufacturer's/Supplier Name : M/s Shri Badrinath Vaikalpik Urja Ltd.
 Daudwala, Post office – Mothrowala
 Dehradun – 248001 (Uttarakhand)

Site : Regional Test Centre
 Deenbandhu Chhotu Ram University of
 Science & Technology, Murthal

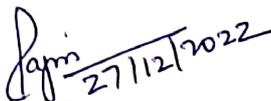
Date : 01.12.2022 to 14.12.2022

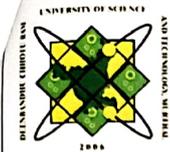
Test Data

| Sr. No. | Time | Ambient Temp. | Average Global Radiation (I) | Average Temp. of water in tank | Average Wind Speed |
|-------------------------|-------|---------------|------------------------------------|--------------------------------|--------------------|
| | Hrs. | °C | W/m ² | °C | m/s |
| Date: 01.12.2022 | | | Solar Noon Time: 12:21 Hrs. | | |
| 1 | 8:40 | 15.6 | 416 | 38.5 | 0.6 |
| 2 | 9:10 | 16.1 | 496 | 40.1 | 0.8 |
| 3 | 9:40 | 16.9 | 571 | 41.3 | 0.4 |
| 4 | 10:10 | 16.9 | 650 | 42.9 | 2.3 |
| 5 | 10:40 | 17.8 | 704 | 44.7 | 0.7 |
| 6 | 11:10 | 17.9 | 748 | 46.2 | 0.3 |
| 7 | 11:40 | 18.5 | 806 | 48.3 | 1.7 |
| 8 | 12:10 | 18.9 | 829 | 50.3 | 1.1 |
| 9 | 12:40 | 19 | 822 | 52.4 | 1.3 |
| 10 | 13:10 | 19.7 | 811 | 54.4 | 1.8 |
| 11 | 13:40 | 19.6 | 812 | 56.4 | 2.4 |
| 12 | 14:10 | 20.1 | 763 | 58.4 | 1.9 |
| 13 | 14:40 | 20.3 | 725 | 60.2 | 1.6 |
| 14 | 15:10 | 20.4 | 670 | 62.4 | 1.9 |
| 15 | 15:40 | 20.7 | 591 | 64.3 | 1.7 |


 Technical Manager
 (Ravi)


 Quality Manager
 (Dheeraj Yadav)

 27/12/2022
 Authorized Signatory
 (Prof. Rajni Shukla)
 Regional Testing Centre
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 Murthal, Sonapat-131039 Hariana



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Test Results

| Date of Test | T _{sid} | T _{afd} | Average Ambient Temp. T _{ad} | Average Solar Radiation, GT | (1+2)/2 | ΔT | X | η | % η |
|--------------|------------------|------------------|---------------------------------------|-----------------------------|----------|-------|------|------|------|
| | °C | °C | °C | W/m ² | | | | | |
| | 1 | 2 | 3 | 4 | 5 | | | | |
| 01.12.2022 | 18.4 | 45.8 | 19.4 | 747 | 32.10 | 12.70 | 0.02 | 0.55 | 55.4 |
| 02.12.2022 | 21.1 | 45.6 | 22.0 | 637 | 33.35 | 11.35 | 0.02 | 0.58 | 58.1 |
| 05.12.2022 | 24.4 | 47.9 | 22.8 | 642 | 36.15 | 13.35 | 0.02 | 0.55 | 55.3 |
| 06.12.2022 | 30.8 | 51.3 | 20.5 | 648 | 41.05 | 20.55 | 0.03 | 0.48 | 47.8 |
| 07.12.2022 | 31 | 58.5 | 19.6 | 692 | 44.75 | 25.15 | 0.04 | 0.60 | 60.0 |
| 08.12.2022 | 33.1 | 56.7 | 22.2 | 739 | 44.9 | 22.7 | 0.03 | 0.48 | 48.2 |
| 09.12.2022 | 35.9 | 58.8 | 21.3 | 735 | 47.35 | 26.05 | 0.04 | 0.47 | 47.0 |
| 12.12.2022 | 39 | 58.8 | 23.6 | 637 | 48.9 | 25.3 | 0.04 | 0.47 | 46.9 |
| 13.12.2022 | 41.7 | 63.4 | 27.3 | 688 | 52.55 | 25.25 | 0.04 | 0.48 | 47.6 |
| 14.12.2022 | 44.2 | 63.6 | 22.8 | 652 | 53.9 | 31.1 | 0.05 | 0.45 | 44.9 |

Conclusion from graph plotted as per standards:

From graph:

η_c: 0.62

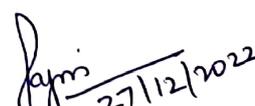
U_{sd}.....: 3.59

Equation for efficiency: η_{system} = η_c - U_{sd} . X

: η_{system} = 0.62 - 3.59.X


Technical Manager
(Ravi)


Quality Manager
(Dheeraj Yadav)


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Deenbandhu Chhotu Ram University of Science & Technology
Murthal, Sonapat-131039, Haryana

| | | |
|---|--|---|
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For Standard Test Conditions:

Average Tank Storage Temperature, T_s : 50°C
 Average Ambient Temperature, T_{ad} : 25°C
 Average Global Radiation, GT : 700 W/m²

$X = 0.03 \text{ m}^2\text{K/W}$

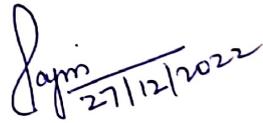
| Sr. No. | Specifications/Tests | Specified Requirements | Results |
|---------|--|------------------------|---------|
| 1. | Thermal Performance Test (As per IS 16544:2016 Cl No. 6.2.6) | ≥ 35 % | 51 |

$\eta_{\text{system}} : 0.51$

Performance of the system: Satisfactory


 Technical Manager
 (Ravi)


 Quality Manager
 (Dheeraj Yadav)


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 Regional Testing Centre
 Centre of Excellence for Renewable Energy Test Centre (RETC),
 Deenbandhu Chhotu Ram University of Science & Technology,
 Murthal, Saran, Jharkhand, India



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DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE & TECHNOLOGY

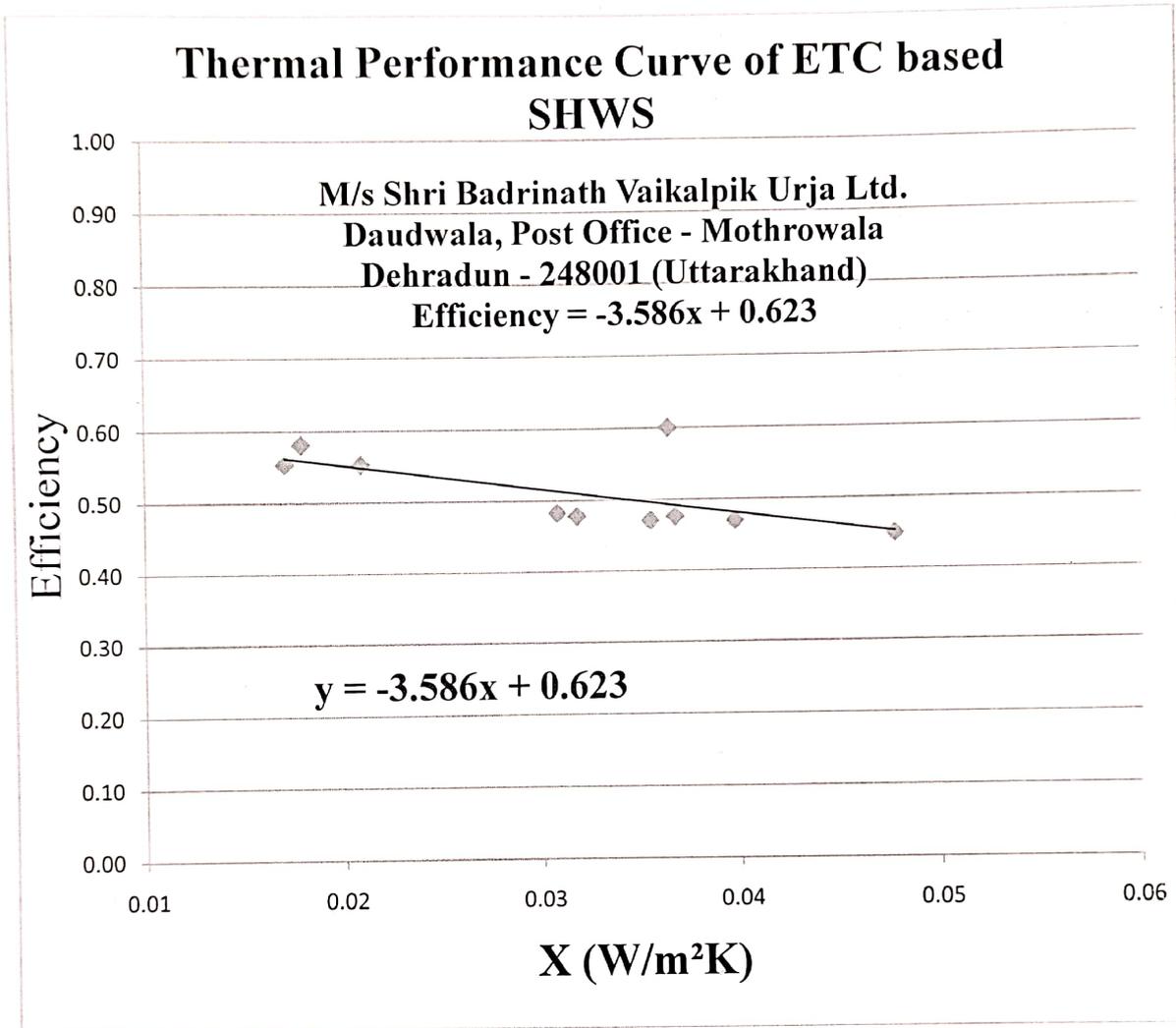


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Test Report No. TC857122000000055F

Page No. 08/09



[Signature]
Technical Manager
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Quality Manager
(Dheeraj Yadav)

[Signature] 27/12/2022
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Centre of excellence for Renewable Energy Test Centre (RETC),
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TC-8571

Test Report No. TC857122000000055F

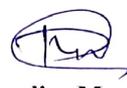
Page No. 09/09

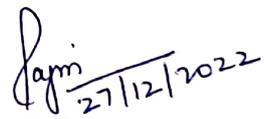
Night Time Data**Test Results**

| Date of Test | Avg. Tank Temperature at 19:00 Hrs. | Avg. Tank Temperature at 07:00 Hrs. | Avg. Ambient Temp. during Test | $\ln [(2-3)/(1-3)]$ | U_{night} K2 = 19.38 | (2-3)/(1-3) |
|--------------|-------------------------------------|-------------------------------------|--------------------------------|---------------------|----------------------------------|-------------|
| 01.12.2022 | 46.9 | 39.9 | 11.4 | -0.22 | -1.93 | 0.80 |
| 02.12.2022 | 41.4 | 33.8 | 14 | -0.32 | -2.86 | 0.72 |
| 05.12.2022 | 43.2 | 36.1 | 17.2 | -0.32 | -2.81 | 0.73 |
| 06.12.2022 | 47.2 | 41.3 | 16.3 | -0.21 | -1.87 | 0.81 |
| 07.12.2022 | 48.8 | 45.4 | 14.6 | -0.10 | -0.92 | 0.90 |
| 08.12.2022 | 44.2 | 39.4 | 16.9 | -0.19 | -1.70 | 0.82 |
| 09.12.2022 | 52.5 | 44.7 | 11.8 | -0.21 | -1.87 | 0.81 |
| 12.12.2022 | 52.5 | 44.8 | 11.7 | -0.21 | -1.84 | 0.81 |
| 13.12.2022 | 52.5 | 44.5 | 10.8 | -0.21 | -1.88 | 0.81 |
| 14.12.2022 | 55.3 | 46.5 | 11.6 | -0.22 | -1.98 | 0.80 |

Average $U_{\text{night}} = -1.97 \text{ W/m}^2\text{K}$


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-----END OF TEST REPORT-----



| | | |
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No. RETC/ 132

Date 27/12/22

To

M/s Shri Badrinath Vaikalpik Urja Ltd.
Daudwala, Post office – Mothrowala
Dehradun – 248001 (Uttarakhand)

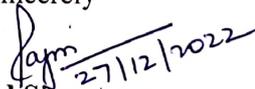
Subject: Testing of All Glass Evacuated Solar collector Tube (58 X 2100 mm) Submitted by you.

Dear Sir,

I am enclosing herewith testing report of All Glass Evacuated Solar collector Tube (58 X 2100 mm) submitted by you, bearing Report No RETC/RTC/ETC/54/2022. Kindly collect your test sample within 30 days of the issue of this report from RTC, Murthal. The centre will not be responsible for the system after the mentioned days.

Thanking you.

Yours Sincerely


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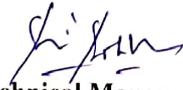
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TEST REPORT FOR ALL GLASS EVACUATED SOLAR COLLECTOR TUBE AS PER IS 16543:2016

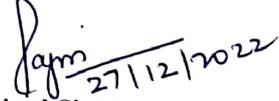
Test Report No. TC85712200000055F

Page No. 01/02

| I. Evacuated Tube (ET) | | | | |
|-------------------------------|----------------------|---|---|--|
| (i) | a. | Make/Model | ENVICTAS | |
| | b. | Complete address of the manufacturer/Supplier including e-mail/web site, etc. | M/s Shri Badrinath Vaikalpik Urja Ltd. Daudwala, Post office – Mothrowala Dehradun – 248001 (Uttarakhand) E-mail Id - sanjay@shrisolar.com Contact No. 9758639375 | |
| | c. | Sample Name and Type | All glass evacuated solar collector tube | |
| | d. | Tube length, L | 2100.10 mm | |
| | e. | Outer diameter of inner tube (as per manufacturer's report), d | 47.00 mm | |
| | f. | Outer diameter of outer tube, D | 58.20 mm | |
| | g. | Details of Selective Coating (as per manufacturer's report) | AI-N-AI | |
| | h. | Aperture (exposed) area of a single tube | 0.275 | |
| (ii) | Test Results: | | | |
| | | Specifications/Tests | Specified Requirements | Results |
| | a. | Stagnation performance parameter test (As per IS 16543:2016 Cl no. 7.3) | $\geq 190 \text{ m}^2, ^\circ\text{C}/\text{kw}$ | 389.64 $\text{m}^2, ^\circ\text{C}/\text{kw}$ |
| | b. | Resistance to thermal shock test (As per IS 16543:2016 Cl no. 7.7) | No appearance of any cracking | No any Cracking is found |
| | c. | Stagnation solar irradiance test (As per IS 16543:2016 Cl no. 7.4) | $\leq 3.7 \text{ MJ}/\text{m}^2$ for 47 mm outside dia cover glass tube $\leq 4.7 \text{ MJ}/\text{m}^2$ for 58 mm outside dia cover glass tube $\leq 5.7 \text{ MJ}/\text{m}^2$ for 70 mm outside dia cover glass tube | 3.45 MJ/m^2 |
| | d. | Average heat loss coefficient test (As per IS 16543:2016 Cl no. 7.5) | $\leq 0.85 \text{ W}/\text{m}^2 \text{ } ^\circ\text{C}$ | 0.52 $\text{W}/\text{m}^2 \text{ } ^\circ\text{C}$ |
| | e. | Resistance to internal pressure test (As per IS 16543:2016 Cl no. 7.9) | No appearance of any damage | No any Damage is found. |
| | f. | Resistance to impact test (As per IS 16543:2016 Cl no. 7.8) | No appearance of any damage/crack | No any damage /crack is found |


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 Regional Testing Centre
 Centre of Excellence for Renewable Energy Test Centre (RETC),
 Deenbandhu Chhotu Ram University of Science & Technology
 Murthal, Sonapat-131009, Haryana

Test Report No. TC85712200000055F

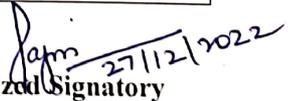
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|--|----|--|--|--|
| | g. | Vacuum performance test (As per IS 16543:2016 Cl no. 7.6) i. Air pressure test ii. Vacuum quality test | ----- ----- | Presence of Vacuum standard is observed. Getter Mirror not disappear more than 50% |
| | h. | Selective coating: (As per IS 16543:2016 Cl no. 7.10) i. Absorptivity test ii. Emissivity test | ≥ 0.92 $\leq 7\%$ | 0.92 7 % |
| | i. | External Thermal Shock Test (As per IS 16544:2016 Cl no. 6.2.4) | No appearance of any cracking, distortion and deforming of collector | No any appearance of any cracking, distortion and deforming of collector is found. |
| | j. | Internal Thermal Shock Test (As per IS 16544:2016 Cl no. 6.2.5) | No appearance of any cracking, distortion and deforming of collector | No any appearance of any cracking, distortion and deforming of collector is found. |
| | k. | Thermal Shock Test for inner sealing (As per IS 16542:2016 Cl no. 7.6) | No appearance of any cracks or brittleness | No any appearance of any cracks or brittleness is found. |
| | l. | Thermal Shock Test for outer sealing (As per IS 16542:2016 Cl no. 7.7) | No appearance of any cracks or brittleness | No any appearance of any cracks or brittleness is found. |
| | | Any other details | | |
| | | Remarks | | |

1. This report in full or in party may not be published or advertised or used for any legal action unless prior permission has been secured from this test centre.
2. This test report refers only to the specimen supplied.
3. The results presented here relate only to the conditions of the measurement at the time of testing.
4. Any queries or suggestion related to this report will not be entertained after one month of receipt of this report.
5. * Indicates the data provided by customer/manufacturer.


Technical Manager
 (Ravi)


Quality Manager
 (Dhceraj Yadav)


Authorized Signatory
 (Prof. Rajni Shukla)
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