

JIS

JAPANESE INDUSTRIAL STANDARD

Solar Collectors

JIS A 4112—1988

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In the event of any doubt arising,
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Solar Collectors

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1. Scope

This Japanese Industrial Standard specifies solar collectors, hereinafter referred to as the "collectors", of nonpersuit type such as flat plate type, vacuum glass tube type, etc. for forced circulation of collection medium. Therefore, this applies to collectors provided with reflector, those provided with light condenser, and those provided with actuation medium for heat transfer to heat collecting medium from heat collecting body such as heat pipe, but does not apply to collectors having a large heat capacity or heat accumulation function in inside of collector.

Remark: In this Standard the units and numerical values shown in { } are in accordance with the conventional units and are Standard value.

2. Definitions

For the purposes of this Standard following definitions apply:

- (1) heat collecting body The part to absorb the incident solar radiation energy to convert to heat energy and to transfer to heat collecting medium.
- (2) heat collecting medium The medium to transfer to heat utilizing system by taking out heat energy from the collector.
- (3) actuation medium The medium to transfer heat energy from heat collecting body to heat collecting medium in heat pipe type, heat pump type collectors, etc. and includes coolant of heat pump type.
- (4) non-freezing solution The liquid to prevent breakage of collector, and piping due to freezing of water, and herein it is limited to aqueous solution.
- (5) transmitting body The part to be used for surface of collector to decrease convection from heat collecting body and the radiation heat loss by transmitting solar light.
- (6) reflecting body The part to increase the incident amount to the heat collecting body by reflecting the solar radiation energy.

- (7) converging body The reflecting body of lens and curved surface or folding plate state to converge the solar radiation energy optically into heat collecting body.
- (8) heat collecting plane The plane just before the heat collecting body which is parallel to the plane for the projection area to be maximum by parallel light rays of heat collecting body. However, in collector provided with a converging body, the plane for the opening area of converging body to be maximum.
- (9) overall area of collector The product of the maximum width and the maximum length of collector excluding protruding parts such as collector metal fittings, piping connecting opening, etc.
- (10) solar radiation intensity of heat collecting surface The amount of solar radiation energy for the unit area of heat collecting surface to receive in unit time.
- (11) heat collecting amount The heat energy to be obtained in heat collecting medium by collector, and it is the value of circulation heat capacity flow rate (mass flow rate x average specific heat) multiplied by temperature difference at outlet and inlet. However, in the case of heat pump type, the value of mass flow rate of actuation medium multiplied by specific enthalpy difference.
- (12) instantaneous heat collection efficiency The heat collecting amount of collector (excluding heat pump type, and in the case of heat pump type, the difference of heat collection amounts over a definite period of time in the state where solar radiation exists and the state where solar radiation does not exist at the point where $\Delta\theta$ (average temperature of heat collecting medium subtracted by atmospheric temperature) is same, divided by the integral value in the same period of time of the solar radiation energy incident to the total area of collector.
- (13) blank burning The fact receiving the solar radiation energy in the state of the collector containing no heat collecting medium and in the case of heat pipe type and heat pump type collectors, in the state where the actuation medium is entered.
- (14) ray transmissivity In the case of collectors having transmitting body, the ratio of transmitted energy through transmitting body relative to incident energy.
- (15) water service direct connecting type The system to supply water by connecting directly with water service by using the pressure reducing valve, check valve, relief valve, etc.
- (16) highest using pressure The highest pressure of heat collecting medium allowable in using state of collector.
- (17) remarkable deformation The state where the structural bodies of collector are deformed by receiving outer force or heat and the safety, functional ability, reliability or endurance of collector is interferenced.

- (18) solar simulator The apparatus to generate light rays simulated to solar spectra in order to carry out heat collecting performance test of collector or the like in a room.
- (19) radiation illuminance The radiation energy which the radiated surface receives per unit area per unit time by solar simulator.
- (20) heat collection efficiency variable The value of temperature difference between the average temperature of heat collecting medium and the air temperature or environmental temperature divided by solar radiation intensity of heat collecting surface or radiation illuminance.

3. Types of Collectors and Name of Each Part

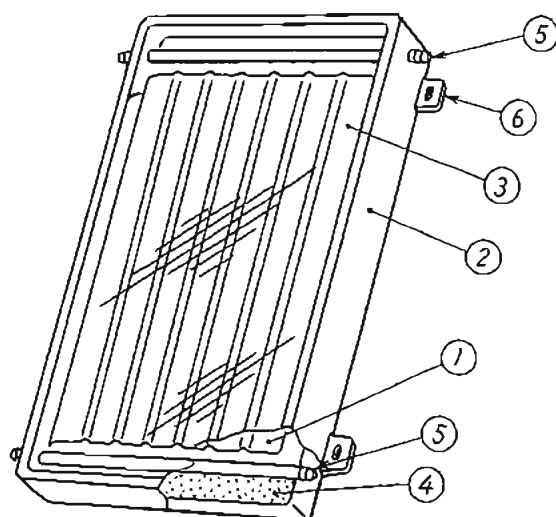
Types of collectors and the name of each part shall be in accordance with Table 1 and Fig. 1.

Table 1. Types of Collectors

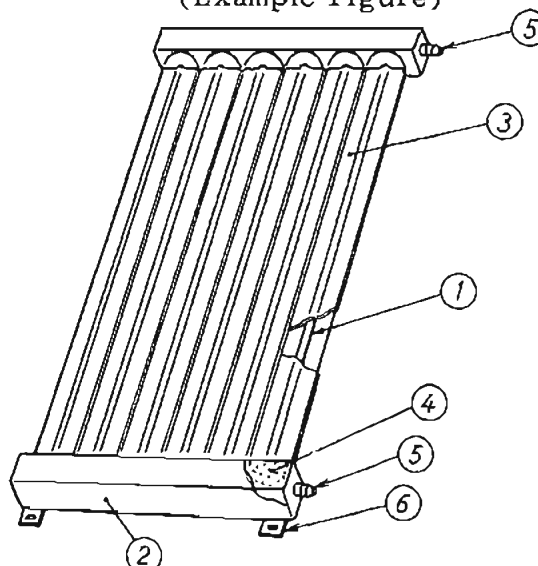
Type	Contents
Flat plate type	The type of which light receiving surface side of heat collecting body stored in a casing of metal, resin or the like is covered by transmitting body or the type having no transmitting body is included.
Vacuum glass tube type	The type in which the heat collecting body is held in vacuum glass tubes.
Heat pump type	The type in which the solar light energy obtained by heat collecting body and the heat in atmosphere are collected by heat pump and having no blower.
Heat pipe type	The type in which the solar light energy obtained by heat collecting body is collected by heat pipe.

Fig. 1. Name of Each Part of Collector

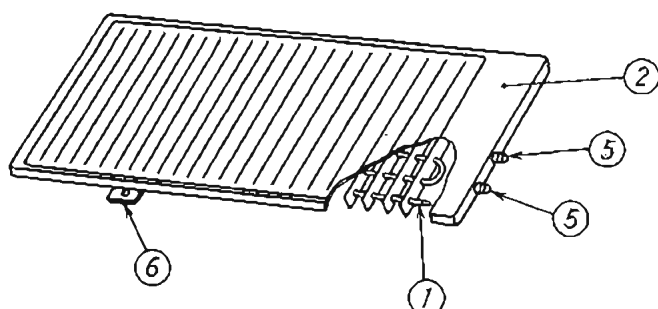
Flat Plate Type (Example Figure)



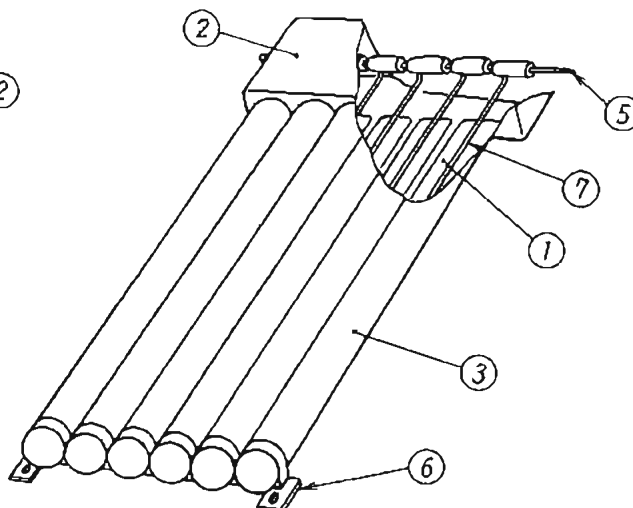
Vacuum Glass Tube Type (Example Figure)



Heat Pump Type (Example Figure)



Heat Pipe Type (Example Figure)



No.	Name
①	Heat collecting body
②	Armour box
③	Transmitting body
④	Heat insulation body
⑤	Piping connecting opening
⑥	Metal fitting
⑦	Heat pipe

4. Performance

The performance of collector shall be subjected to test according to the method of 8. and, comply with specifications of Table 2.

Table 2

Item	Performance	Test method
Heat collecting performance	(1) Flat plate type, vacuum glass tube type and heat pipe type The heat collecting amount, when solar radiation amount is $20934 \text{ kJ/m}^2 \cdot \text{day}$ $\{5000 \text{ kcal/m}^2 \cdot \text{day}\}$, and $\Delta\theta$ is at 10°C shall be 8374 kJ/m^2 $\{2000 \text{ kcal/m}^2\}$. (2) Heat pump type When the instantaneous heat collection efficiency at actuating point ($\Delta\theta$) is not less than 0.4 and the solar radiation amount is $20934 \text{ kJ/m}^2 \cdot \text{day}$ $\{5000 \text{ kcal/m}^2 \cdot \text{day}\}$, the heat collection amount at the actuating point ($\Delta\theta$) shall be not less than 8374 kJ/m^2 $\{2000 \text{ kcal/m}^2\}$.	8.1
Pressure loss	The pressure loss characteristic curve is shown (excepting heat pump type).	8.2
Leakage resistance	Heat collecting body or actuating medium is free from leakage.	8.3
Freezing resistance	To be free from leakage.	8.4
Blank burning resistance	To be free from rupture and remarkable deformation (excepting heat pump type).	8.5
Boiling resistance	To be free from rupture and remarkable deformation (excepting heat pump type).	8.6
Heat impact water passing resistance	To be free from rupture and remarkable deformation (excepting heat pump type).	8.7
Heat impact sprinkling resistance	To be free from remarkable deformation (excepting heat pump type).	8.8

Table 2 (Continued)

Item		Performance	Test method	
Strength	Strength of body	(1) To be free from rupture and remarkable deformation. (2) In the case where the transmitting body is of plastics, it is not adhered tightly to the heat collecting body.	8.9	
	Strength of attaching part	To be free from rupture, remarkable deformation, and separation of attaching part.	8.10	
	Rigidity	To be free from rupture and remarkable deformation.	8.11	
	Impact resistance of transmitting body	To be free from rupture (excepting those having no transmitting body).	8.12	
Endurance	Painting film performance of heat collecting body and armour box	Adhesiveness	To be free from exfoliation of painting film.	8.13
		Salt water spray	To be free from cracking, swelling, peeling and rust.	8.14
	Painting film performance of heat collecting body	Heat resistance	Holding rate of absorption rate α is not less than 90 %.	8.15
		Weathering resistance	Holding rate of absorption rate α is not less than 90 %.	8.16
	Tensile strength of plastics for armour	Glass fiber reinforced polyester	To be not less than 1960 N/cm ² {200 kgf/cm ² }.	8.17
		Polyethylene, polypropylene	To be not less than 1470 N/cm ² {150 kgf/cm ² }, holding rate is not less than 60 %.	
	Plastic transmitting body	Transmissivity	To be not less than 75 % of initial value.	8.18
	Reflecting body	Reflectivity	To be not less than 70 % of initial value.	8.19

5. Structure General

The structure of collector shall be as follows:

- (1) The collector is of such structure as to cause no leakage of heat collecting medium.
- (2) Each part of collector has sufficient strength.

- (3) The using material of collector is provided with sufficient endurance.
- (4) The collector to be used for hot-water supply is not used with such material to elute hygienically harmful substance at water contacting part.
- (5) The heat pipe type and heat pump type collectors are of such structure as not to cause leakage of actuating medium. The actuating medium is not harmful hygienically.
- (6) The connecting parts of outer piping of collector are capable of being executed and checked easily and provided with sufficient strength against outer force.
Further, effective countermeasures are exerted against outer force.
- (7) The collector is of such structure that remarkable noise and vibration are not generated during using.
- (8) The collector is of such structure that rain water and dust are difficult to enter and even if those entered, heavy (permanent) interference is not caused to heat collecting performance.
- (9) Each part of collector is of such structure that is sufficiently considered against snow, and ice freezing.
- (10) The fixing part of collector is of such structure that it is capable of fixing easily with frame stand, building frame, etc. by metal fittings and further the safety on fixing method, strength, etc. is secured sufficiently.
- (11) When steel plate and steel pipe are used for armour box or fixing part of collector, the sufficient corrosion resistance countermeasures are exerted.
- (12) The collector is of such structure that main parts are capable of exchanging and maintenance and checking can be carried out easily.
- (13) The improvement of heat insulation performance is designed by suitable using of heat insulating material.
- (14) Appliances or system for preventing damage due to freezing rupture and boiling is exerted with required countermeasures.

6. Appearance

The finishing of outer parts is workmanlike and free from harmful defects such as cracking, dirt, rust, burrs, etc.

7. Materials

7.1 Materials to be used for transmitting body shall be those specified in Japanese Industrial Standards shown in Table 3 or those provided with the quality equivalent or superior thereto.

Table 3

Material	Standard
Polymethylmethacrylate sheet	JIS K 6718
Polycarbonate	JIS K 6719
Polyvinyl chloride	JIS K 6732 JIS K 6742 JIS K 6745
Polyethylene	JIS K 6781
Polystyrene	JIS K 6872
Polytetrafluoroethylene resin	JIS K 6888
Polyester resin	JIS K 6919
Glass	JIS R 3201 JIS R 3202 JIS R 3206
Glass fiber reinforced polyester	JIS R 3411 JIS R 3412 JIS R 3417
Acrylonitrile-Butadiene-Styrene resin	JIS A 5701 JIS K 6873

7.2 Materials to be used for contacting part of heat collecting body and medium shall be those specified in Japanese Industrial Standards shown in Table 4 or those provided with the quality equal or superior thereto.

Table 4

Material	Standard
Fitting	JIS B 2301 JIS B 2302
Steel sheets and plates, strip and coiled sheets	JIS G 3131 JIS G 3141
Surface treated steel sheets and plates	JIS G 3302 JIS G 3312 JIS G 3313
Steel pipe	JIS G 3442 JIS G 3452 JIS G 3459
Stainless steel sheets and plates, and steel strip	JIS G 4305 JIS G 4307
Copper and copper alloy-sheets, plates, strip and coiled sheets and rods and bars	JIS H 3100 JIS H 3250
Copper pipes and fittings	JIS H 3300 JIS H 3401
Aluminium and aluminium alloy sheets and plates, strip and coiled sheets and extruded shapes	JIS H 4000 JIS H 4100
Bronze castings	JIS H 5111
Synthetic rubber	JIS K 6353
Polyvinyl chloride, polyvinyl chloride pipes and fittings	JIS K 6720 JIS K 6741 JIS K 6742 JIS K 6743 JIS K 6745
Polypropylene	JIS K 6747
Polyethylene, polyethylene pipes and fittings	JIS K 6748 JIS K 6761 JIS K 6762 JIS K 6763
Liquid unsaturated polyester for reinforced plastics	JIS K 6919
Glass fiber reinforced polyester	JIS R 3411 JIS R 3412 JIS R 3417