Influence of the surface on the absorption of solar energy with ADM3

Physics | Energy | Renewable energies: Sun

Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	20 minutes

This content can also be found online at:

http://localhost:1337/c/64a653ef108e10000205af51

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General information

Application

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Source photo: wikipedia

Influence of the surface on the absorption of solar energy

In solar technology, the absorber is an integral part of the solar collectors. When using absorbers in the form of a plate, a large surface area can be turned towards the sun with a small volume.

In order to achieve the highest possible absorption of solar energy, the surface is coloured black or provided with a special coating.

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Other information (1/2)

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Prior knowledge

The heating of a body in sunlight depends on its surface colour. White surfaces reflect the entire visible spectrum, while black surfaces absorb it completely.

Principle

A black and a white plate are placed next to each other on the board and illuminated with a reflector lamp.

The temperature measurement on both plates shows a clear difference in the absorption behaviour of both plates after only a short time.

Other information (2/2)

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Note

With a slightly modified experimental set-up, the influence of thermal insulation on the absorption of solar energy can also be investigated. Here, the heating of a black plate is compared with that of a black plate insulated on the back.

The black panel is attached to the centre of the magnetically adhering support plate. The polystyrene board serves as thermal insulation.

The two measurements must then be carried out one after the other (as a "repeat measurement").

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

For H and P phrases, please refer to the safety data sheet of the respective chemical.

Theory

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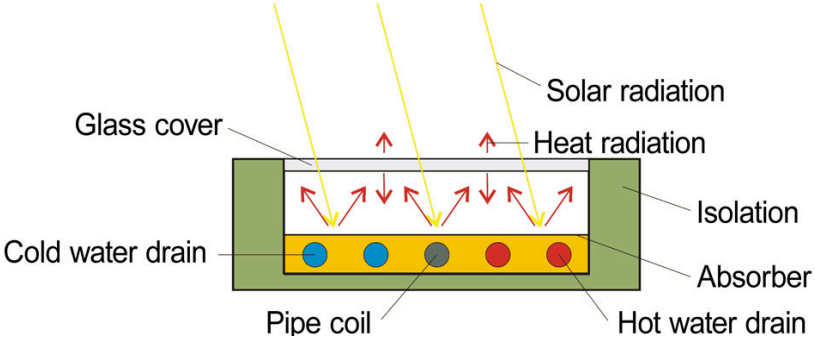

Source photo: wikipedia

The incident solar radiation is converted into thermal energy by absorption and transferred to a liquid flowing through it.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	PHYWE Demo Multimeter ADM 3: current, voltage, resistance, temperature	13840-00	2
3	Clamp on holder	02164-00	1
4	Solar ray collector, magnetic	02165-00	1
5	Support rod, stainless steel, 750 mm	02033-00	1
6	Ceramic lamp socket E27, with reflector, switch and security plug	06751-01	1
7	Filament lamp, 220V/120W, with reflector	06759-93	1
8	Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	2
9	G-clamp	02014-01	2

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Setup and procedure

Setup (1/2)

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- Set up the experiment according to the illustration.
- Put the white and the black plate of the solar collector on the magnetically adhering support plate of the solar collector and screw it tight so that the measuring sockets each have good thermal contact with the plates.
- Insert the two immersion probe of the multimeters into the measuring sockets of the support plate.

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Setup (2/2)

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- Above the solar collector on the upper edge of the demo board, carefully clamp the sleeve onto the support and fix the support rod in it.
- Attach the reflector lamp to the end of the support rod and point it centrally at the solar collector (distance approx. 35 cm).

Procedure

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- Switch on the lamp and the ADM3 multimeters.
- Start the measurement recording and stop it again after 20 minutes.
- Enter the temperature of the two plates for each minute in the chart on the next page.

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Evaluation (1/2)

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Minute	1	2	3	4	5	6	7	8	9	10
black Plate (in °C)										
white Plate (in °C)										

Minute	11	12	13	14	15	16	17	18	19	20
black Plate (in °C)										
white Plate (in °C)										

Evaluation (2/2)

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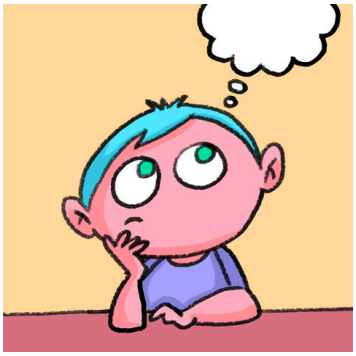
Influence of the surface on the absorption of solar energy



When the two panels are illuminated, the following heats up

- the black plate and the white plate equally fast.
- the white plate much faster than the black one.
- the black plate much faster than the white one.

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Slide	Score / Total
Slide 13: Relationship during heating	0/2

Total score 0 / 2

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