Pumping water using wind energy

Task and equipment

Information for teachers

Additional information

New application areas are being continually looked for to extend the use of renewable energies. Wind, for example, generates energy that is not constant, but the storage of this has been found to be difficult. For this reason, excess wind energy could be used to pump water to a high-up reservoir, so that a hydro-electric power station could utilize the water for power generation on less windy days.
The idea of using wind energy to supply current to a pumped storage electrical power station for the filling of a reservoir is relatively new. It was awarded an environmental promotion prize in Germany in 2006.

Notes on the setup and procedure

The students should always stand behind the wind generator during the experiment to avoid a risk of injury.
Ensure that there is no air in the pump otherwise the pump performance will significantly drop.
It is advisable to use distilled water. This avoids a possible jamming of the impeller and other problems associated with furring up.

Measures for improving the pump performance:
- Switch the voltage source on and off several times so that the water head air that has formed is pressed out by the water return.
- If necessary, incline the pump and then switch the voltage source on and off several times.
- Knock the pump lightly against the bottom of the dish.
- Turn the impeller in the pump should it have jammed, for example because of furring.
(The impeller is visible through the opening in the bottom of the pump.)

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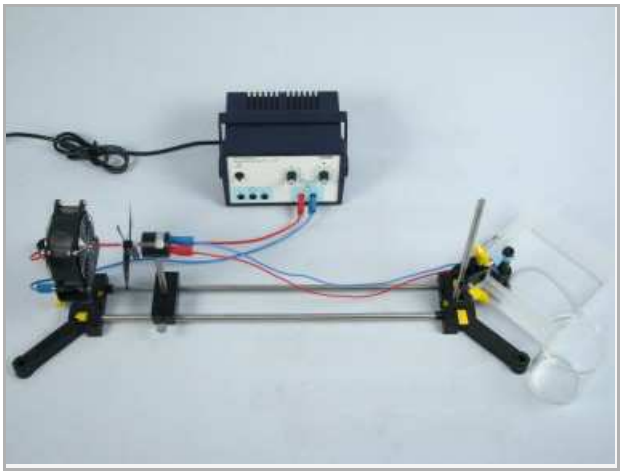
Task

How quickly can water be pumped using wind energy?

In this experiment, the time required by a windwheel to pump water to various heights is measured.



Student's Sheet

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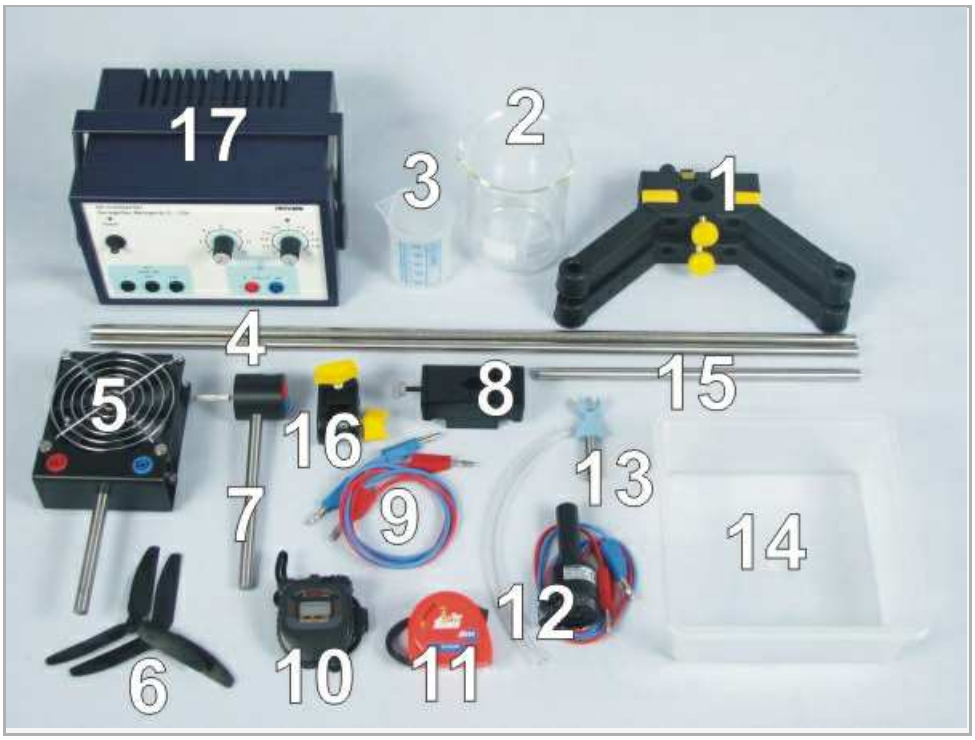
Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Glass beaker DURAN®, short, 400 ml	36014-00	1
3	Beaker, low form, plastic, 100 ml	36011-01	1
4	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
5	Blower, 12V	05750-00	1
6	Rotor, 2 pieces	05752-01	1
7	Generator with metrical thread axis and nut	05751-01	1
8	Slide mount for optical bench	09822-00	1
9	Connecting cord, 32 A, 500 mm, blue	07361-04	1
9	Connecting cord, 32 A, 500 mm, red	07361-01	1
10	Digital stop watch, 24 h, 1/100 s & 1 s	24025-00	1
11	Measuring tape, l = 2 m	09936-00	1
12	Water pump/ water turbine/ generator	05753-00	1
13	clamp, d = 16 mm, with mounting rod	05764-00	1
14	Dish, plastic, 150x150x65 mm	33928-00	1
15	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
16	Boss head	02043-00	1
17	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
Additional material			
	Water		

Set-up and procedure

Set-up

Construct the rail support from the variable support stand and the two rods (Figs.1 and 2).

Fig. 1

Fig. 2

Fit the short support rod in the right part of the support stand and the blower in the right side so that the side with the sockets is facing away from the rail support (Fig. 3).

Fig. 3

Successively plug the two rotors on the axis of the generator (Fig. 4).
The six vanes should be at the same distance from each other, with the writing readable from the front (Fig. 5).

Fig. 4

Fig. 5

Fix the generator in the slide mount and position it on the rail support so that the distance between generator and blower is 5 cm (Fig. 6).

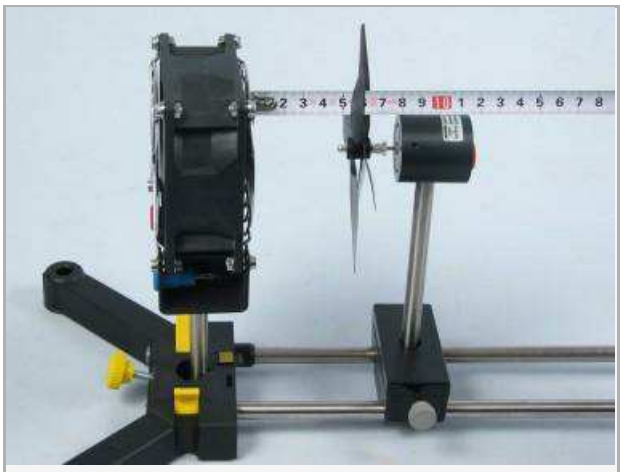


Fig. 6

Connect the blower to the direct voltage output of the power supply with the long cables (Fig. 7).
The power supply is in the switched-off state.

Fig. 7

Use the boss head to fit the clamp on the short rod (Fig. 8).

Fig. 8

Position the plastic dish so that one corner is under the clamp. Fix the tubing to the pump and press the pump in the clamp. Adjust the pump to be at a distance of about 2 mm from the bottom of the dish (Fig. 9).

Fig. 9

Connect the pump to the generator according to the colour marking (Fig. 10).

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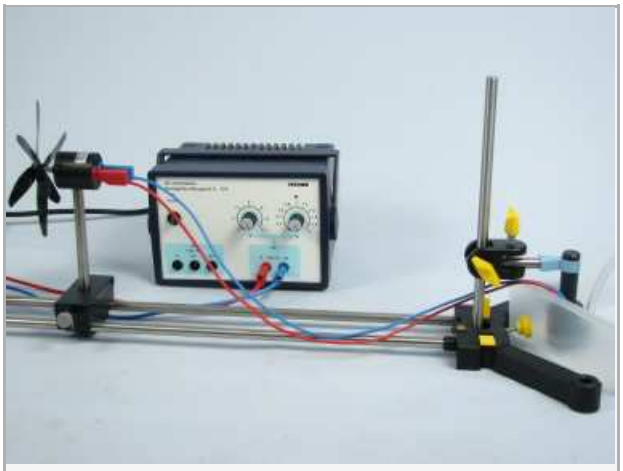

Fig. 10

Fill so much water in the plastic dish that the pump dips about 2 cm into it. Position the large beaker under the free end of the tubing from the pump (Fig. 11).

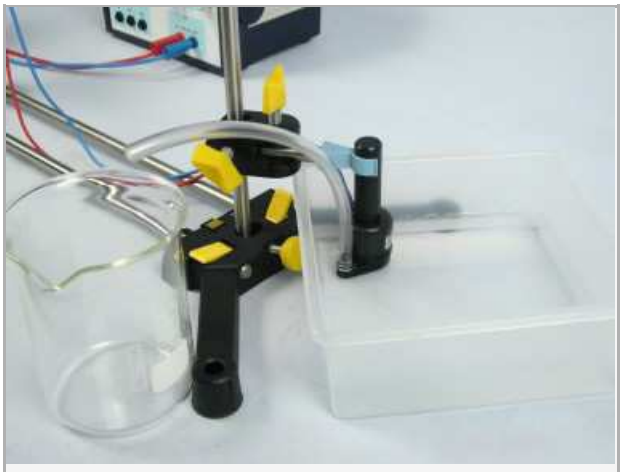

Fig. 11

The complete experimental set-up should now look as shown in Fig.12.

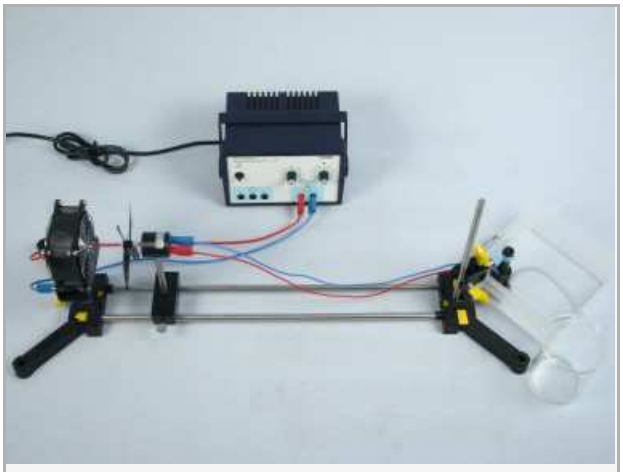

Fig. 12

Procedure

Turn the adjusting knobs for voltage and current completely clockwise.
Make sure that the end of the tubing is above the beaker and bend the tubing so that it runs as flat as possible.
Start the stop watch when you now turn the power supply on (Fig. 13).

Fig. 13

Note the time taken for 100 ml of water to be pumped into the beaker under Result - Observations 1 in the report.

Switch the power supply off and pour the water in the beaker back in the dish.

Replace the large beaker by the small one and press the tubing down.
Again make sure that the end of the tubing is above the beaker and that the tubing runs as flat as possible.
Start the stop watch when you now again turn the power supply on and note the time taken for the collection of 100 ml of water under Result - Observations 2.

Switch the power supply off immediately so that the beaker does not overflow.

Should the pump not run properly, try the following helping measures:
- Knock the pump lightly against the bottom of the dish.
- Switch the power supply on and off several times.
- Turn the impeller from underside the pump.

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Report: Pumping water using wind energy

Result - Observations 1

How long did it take for 100 ml of water to be pumped in the large beaker?

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Result - Observations 2

How long did it take to fill 100 ml of water into the small beaker?

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Evaluation - Question 1

How can the different times be explained with the help of potential energy E = m g h?

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Evaluation - Question 2

What would happen if the wind generator was slowly pushed further away from the blower?

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Evaluation - Question 3

How could the set-up used in this experiment be put to use in practice?

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