

Influence of the number of rotor blades

Task and equipment

Information for teachers

Additional information

From their environment, students usually know of wind turbines that have 3 blades. There are also models with only 2 blades or with completely different structures. In contrast, water wheels have more blades ("Blätter"), and they are suitable for driving large machinery. In the past they were, for example, used for grinding grain.

Wind wheels are used for the production of electrical energy. The optimal number of blades is a consequence of not only the maximum useful energy produced by the wind but also from the necessary material inventory and the stability of the wind wheel while in operation.

Notes on the Setup and Procedure

It is important to ensure that the students always stand behind the blower or behind the wind wheel and do not reach into the space between blower and wind wheel, when voltage is applied to the blower and it turns the wind wheel.

The adjustment knob for the current intensity must be completely turned to the right, so that the blower can reach a supply voltage of 12 V.

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Task

Compare wind wheels that have different numbers of rotor blades.

For the comparison the generator of the wind wheel is equipped first with 3, and then with 6 rotor blades. The wind wheel will then be loaded with a light bulb and secondly a LED, while the output voltages of the wind wheel are measured in response to different wind speeds.



Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
3	Slide mount for optical bench	09822-00	1
4	Rotor, 2 pieces	05752-01	1
5	Generator with metrical thread axis and nut	05751-01	1
6	Blower, 12V	05750-00	1
7	Junction module, SB	05601-10	2
8	Socket module for incandescent lamp E10, SB	05604-00	1
9	Light emitting diode module red , SB	05654-00	1
10	Filament lamps 1.5V/0.15A,E10,10 pieces	06150-03	(1)
11	Connecting cord, 32 A, 250 mm, red	07360-01	1
12	Connecting cord, 32 A, 250 mm, blue	07360-04	1
13	Connecting cord, 32 A, 500 mm, red	07361-01	2
14	Connecting cord, 32 A, 500 mm, blue	07361-04	2
15	DMM with NiCr-Ni thermo couple	07122-00	1
16	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13505-93	1

Set-up and procedure

Set-up

Set up the optical bench with the variable tripod foot and both support rods (Fig. 1 and Fig. 2).



Fig. 1



Fig. 2

Fix the blower in the left part of the tripod-foot so that the side with the connection sockets faces away from both tripod support rods (Fig. 3).



Fig. 3

Put both rotors one after another onto the axis of the generator (fig. 4). The six blades should be equidistant from each other (fig. 5).



Fig. 4



Fig. 5

Fasten the generator to the rider and put it on the optical bench (Fig. 6).



Fig. 6

Connect the blower with the AC adapter. The blower has to be connected to the outputs for direct current DC voltage (Fig. 7).



Fig. 7

Connect the multimeter to the generator (Fig. 8) and set the measurement range to 20 volts DC (20 V).

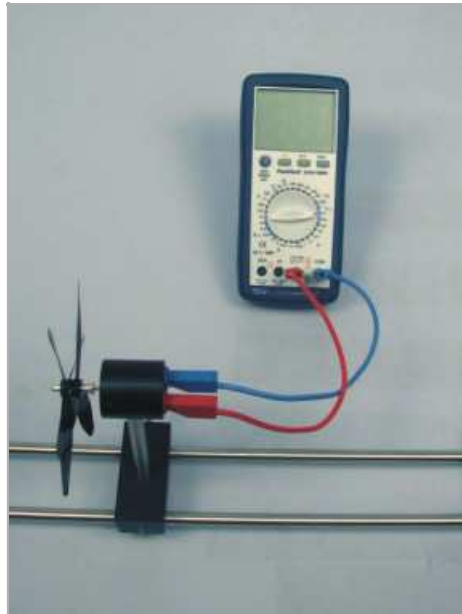


Fig. 8

Procedure

Move the generator in such a way that the distance between the front of the fan and the tip of the generator is about 10 cm (Fig. 9).



Fig. 9

Switch on the power supply and turn the adjustment knob for the intensity of current completely to the right. Adjust the voltage to 6 V.

Write down the voltage values of the wind wheel in Table 1.

Switch off the power supply and wait until the wind wheel stops turning.

Remove one of the rotors from the axis of the generator. Now the wind wheel has only three instead of six rotor blades (Fig. 10).



Fig. 10

Switch on the power supply and write down in Table 1 the voltage displayed by the multimeter. Switch off the power supply.

Repeat the voltage measurements for the supply voltages of 7,8,9,10,11 and 12 cm. Complete Table 1.

Build up the electric circuit according to Fig. 11 and connect it to the generator (Fig. 12).

Connect the multimeter to the generator in such a way that you can measure the voltage (Fig. 13).



Fig. 11

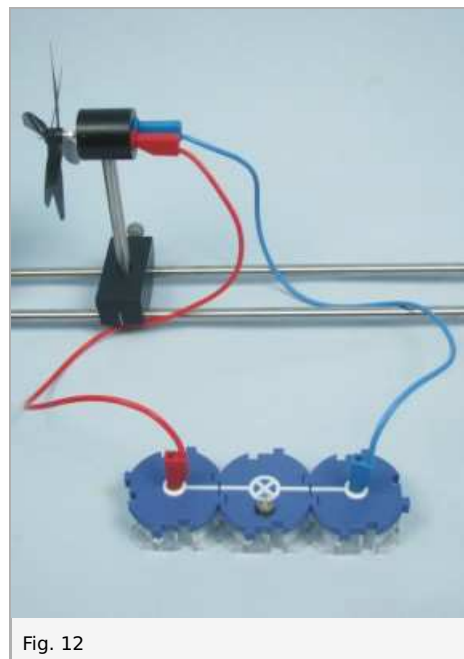


Fig. 12



Fig. 13

Repeat the measurements as described above and note the results in Table 2.

Exchange the bulb socket for the LED (Fig. 14) and repeat the measurements.

Write down the results in Table 3.



Fig. 14

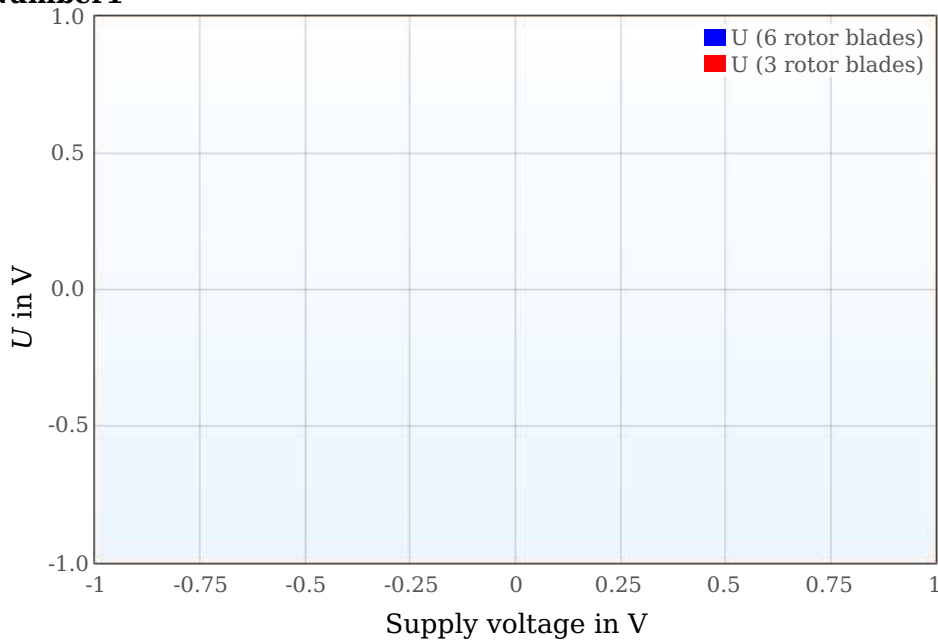
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Result - Table 1

Note your measured values in the table.

Supply voltage in V	U in V (6 rotor blades)	U in V (3 rotor blades)
6	1 ±1	1 ±1
7	1 ±1	1 ±1
8	1 ±1	1 ±1
9	1 ±1	1 ±1
10	1 ±1	1 ±1
11	1 ±1	1 ±1
12	1 ±1	1 ±1

Number1

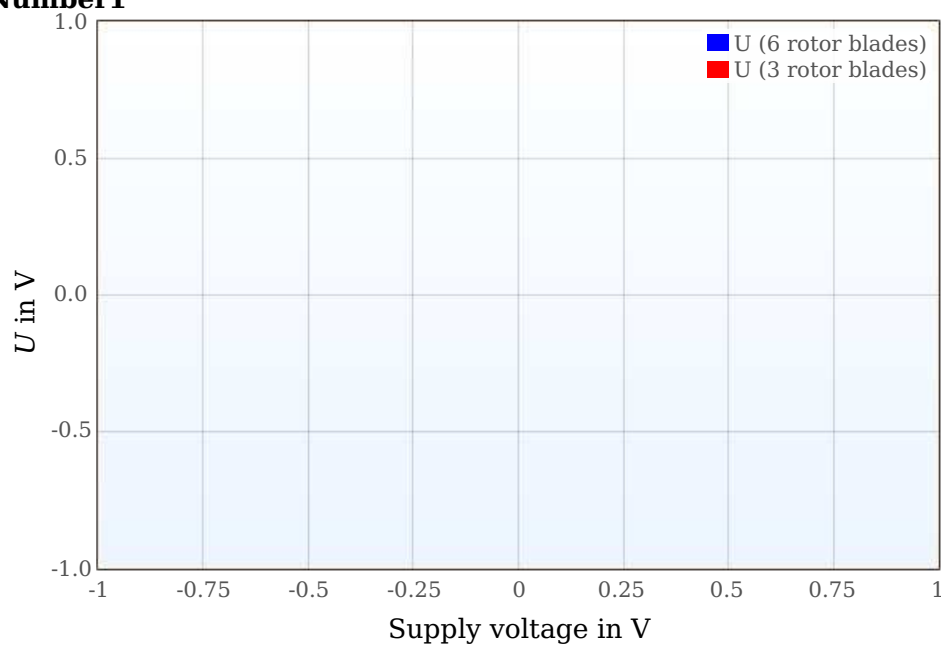


Result - Table 2

Record your measured values in the table.

Supply voltage in V	U in V (6 rotor blades)	U in V (3 rotor blades)
6	1 ± 1	1 ± 1
7	1 ± 1	1 ± 1
8	1 ± 1	1 ± 1
9	1 ± 1	1 ± 1
10	1 ± 1	1 ± 1
11	1 ± 1	1 ± 1
12	1 ± 1	1 ± 1

Number1

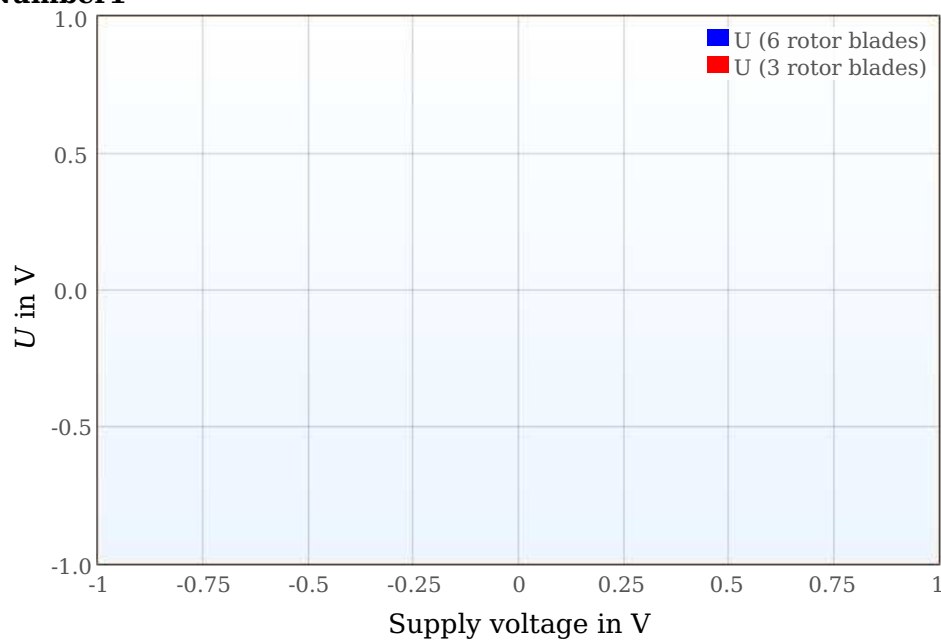


Result - Table 3

Record your measured values in the table.

Versorgungsspannung in V	U in V (6 rotor blades)	U in V (3 rotor blades)
6	1 ± 1	1 ± 1
7	1 ± 1	1 ± 1
8	1 ± 1	1 ± 1
9	1 ± 1	1 ± 1
10	1 ± 1	1 ± 1
11	1 ± 1	1 ± 1
12	1 ± 1	1 ± 1

Number1



Evaluation - Question 1

In Diagram 1, the displayed voltage of the unloaded generator via the supply voltage for the blower (which is equivalent to different wind speeds) with different quantities of rotors was noted; in Diagram 2 the same was noted for a generator which was loaded with an electric light bulb and in Diagram 3, for a generator loaded with a LED.

What general statement can you make?

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Evaluation - Question 2

Compare Diagram 1 (unloaded case) to Diagram 2 (loaded with an electric light bulb).

What statement can you make regarding the generated voltages?

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Evaluation - Question 3

Compare Diagram 1 (unloaded case) to Diagram 3 (loaded with an LED). What statement can you make regarding the generated voltages?

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Evaluation - Question 4

How can you explain your observations?

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