Characteristic curve of a PEM electrolyseur

Task and equipment

Information for teachers

Additional information

The PEM electrolyser consists of a thin, proton-conducting, polymer electrolyte membrane (PEM). The two sides of this are each coated with a catalysing material and act as anode and cathode. The theoretical decomposition voltage of water is 1.23 V, but it is higher in practice because of losses in the electrolyser. In the electrolyser used here it is about 1.5 V. This voltage must be exceeded for water molecules to be decomposed to hydrogen and oxygen.

Notes on the setup and procedure

The electrolyser and the fuel cell are differentiated by colour marking. The electrolyser is blue.
The maximum permissible values for the electrolyser are 2 V for voltage and 2 A for amperage.
Take care that the two openings on each side of the electrolyser are connected with tubing again at the end of the experiment, so that the membrane does not dry out. Refer here to Fig. 1 in Set-up.
The amounts of gas and water in the gas storage can vary according to the filling accuracy. Such a variation can be neglected.
The amount of gas produced in the electrolyser can also vary, according to how moist or dry the electrolyser was at the beginning of the experiment.

Caution:
Use exclusively distilled water in experiments with the electrolyser, otherwise the electrolyser will be damaged beyond repair.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

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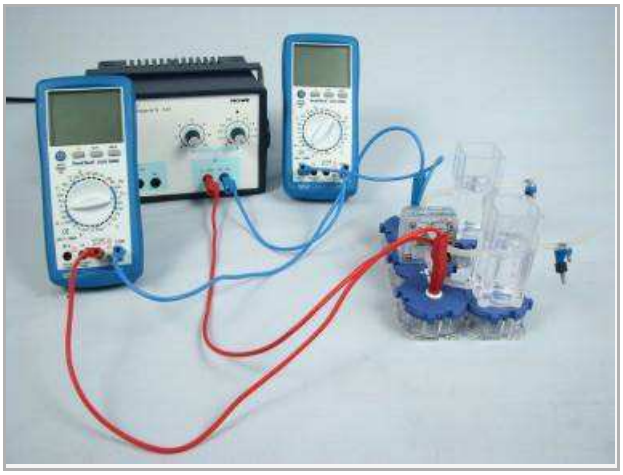
Task

When does an electrolyser start to work?

The current-voltage characteristic of a PEM electrolyser is to be recorded and examined in this experiment.



Student's Sheet

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Equipment

Position No.	Material	Order No.	Quantity
1	Connecting cord, 32 A, 500 mm, red	07361-01	2
2	Connecting cord, 32 A, 250 mm, blue	07360-04	2
3	Connecting cord, 32 A, 500 mm, blue	07361-04	1
4	Junction module, SB	05601-10	2
5	Glass beaker DURAN®, short, 400 ml	36014-00	1
6	Gas storage, SB, incl. tubes and plugs	05663-00	2
7	PEM electrolyser, SB	05662-00	1
8	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
9	DMM with NiCr-Ni thermo couple	07122-00	2
Additional material			
	Distilled water		
	Protective glasses		

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Set-up and procedure

Set-up



H: 220 / 270
P: 210 / 220

- Oxygen is a colourless, odourless and tasteless fire-promoting gas. It is a fire hazard on contact with combustible materials.
- Hydrogen is a colourless, odourless and tasteless combustible gas which easily forms explosive mixtures with air. All sources of ignition must therefore be removed prior to starting experiments which involve hydrogen.
- Wear protective glasses.

Setup

Plug the two junction modules, the two gas storages and the blue-marked electrolyser together as shown in Fig. 1.

Fig. 1

Connect both gas storages to the PEM electrolyser, each with two pieces of tubing. Additionally connect a piece of tubing to the free ends of each of the gas storage and close them with pinchcocks (Fig. 2).

Fig. 2

Have about 150 ml of distilled water filled into your 400 ml glass beaker. Use this water to fill each of the gas storages up to the upper mark from above (Fig. 3).

Caution:
Use only distilled water.

Fig. 3

Open the pinchcocks while holding the free end of the tubing high up, so that water flows down into storage without spillage (Fig. 4).

Fig. 4

Close the pinchcocks again.
Connect the connecting modules to the direct voltage outlets of the power supply according to the shown polarity as shown at the PEM electrolyser. A multimeter for current measurement (ammeter) is here also to be connected in series with the electrolyser (Figs. 5 and 6).

Fig. 5

Fig. 6

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In addition, connect the multimeter for voltage measurement (voltmeter) in parallel with the PEM electrolyser (Figs. 7 and 8).

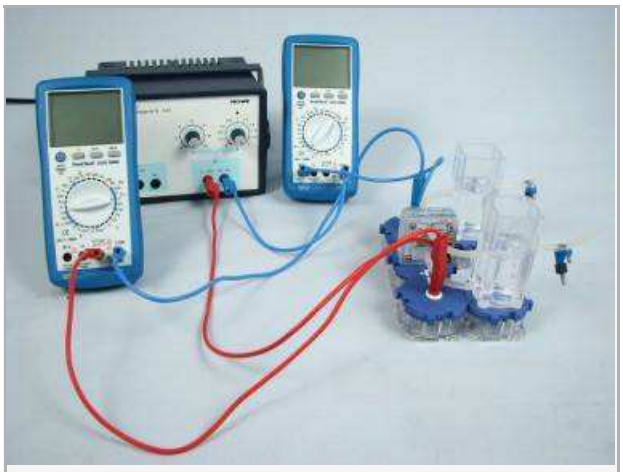

Fig. 7

Fig. 8

Set the ammeter to the 20 A- measurement range and the voltmeter to the 20 V- measurement range. Make sure that the 20 A connection socket is used for the cable connection to the ammeter.

Procedure

Turn the voltage adjusting knob on the power supply fully anticlockwise.

Switch the power supply on and turn the current adjusting knob fully clockwise to 2 A.

Increase the voltage (U) in 200 mV steps from 0 V to 1.40 V and then in 50 mV steps from 1.40 V to 2.00 V.

After each step, wait a little until the current (I) has stabilized and note the value in Table 1.

Emptying gas storage:
With the power supply switched off, remove the cable and the modules. Make sure that the hose clips are closed, then grip the two gas storages, one in each hand. Do not remove the electrolyser. Lift up one gas storage above the beaker and tip the contents out over one corner into the beaker (Fig. 9).

Fig. 9

Carry out the same procedure for the second gas storage.

Report: Characteristic curve of a PEM electrolyser

Result - Table 1

Record the measured values in the table.

U in V	*I* in A
0,00	1 ±1
0,20	1 ±1
0,40	1 ±1
0,60	1 ±1
0,80	1 ±1
1,00	1 ±1
1,20	1 ±1
1,40	1 ±1
1,45	1 ±1
1,50	1 ±1
1,55	1 ±1
1,60	1 ±1
1,65	1 ±1
1,70	1 ±1
1,75	1 ±1
1,80	1 ±1
1,85	1 ±1
1,90	1 ±1
1,95	1 ±1
2,00	1 ±1

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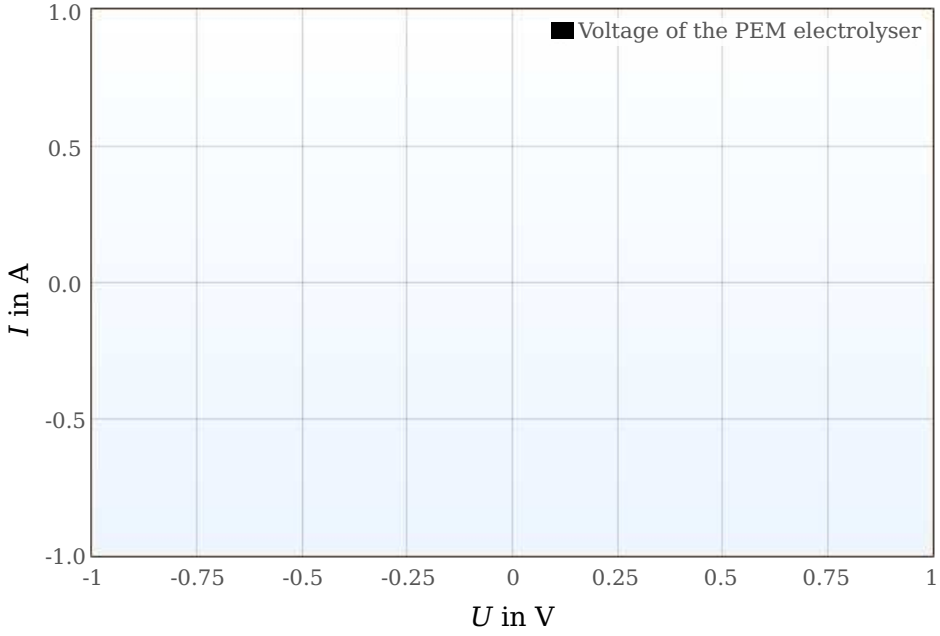
Number1



Evaluation - Question 1

Describe the characteristic curve *I(U)* of the PEM electrolyser that is plotted in the chart of Table 1.

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Evaluation - Question 2

Why does the PEM electrolyser not start producing hydrogen and oxygen at lower voltages?

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