Conversion of electrical energy into thermal energy

AC meter, immersion heater

Objects of the experiment

1. Demonstrate how electrical energy is converted into thermal energy in an immersion heater
2. Compare the electrical energy and thermal energy

Setup

Apparatus

1 Alternating current meter	560 331
1 Single-pan suspension balance 610 Tara	315 23
1 Set of 3 extra weights	315 25
1 Demonstration thermometer, -60 ... +160°C/5 K	382 41
1 Immersion heater	303 25
1 Beaker, Boro3.3, 2000 ml, squat	602 025
1 Ceramic fibre gauze, 200 x 200 mm	667 100
1 CASSY frame	301 350
1 Holder with clamp, height-adjustable, CPS	666 470
1 Universal clamp, 0...80 mm	666 555

Procedure

- Determine the mass m of 2 l of water.
- Read off the meter reading W_0 from the AC electricity meter, along with the water temperature ϑ_0.
- Plug the mains plug of the immersion heater into the earthed socket of the AC meter.
- As soon as the water is boiling, unplug the immersion heater.
- Read off the boiling temperature ϑ_1 of the water and the meter reading W_1.
- Calculate the electrical work W from the meter readings W_0 and W_1.
- Calculate the thermal energy Q from the product of c, m and $\Delta\vartheta$.
- Compare the electrical energy supplied to the immersion heater with the thermal energy it emits.

Measurement results

Meter reading W_0 in kWh	12.70
Meter reading W_1 in kWh	12.86
Temperature ϑ_0 in °C	32
Temperature ϑ_1 in °C	100
Temperature difference $\Delta\vartheta$ in K	68
Specific heat capacity c in $\frac{kJ}{kg \cdot K}$	4.18

Evaluation

$W = W_1 - W_0 = 12.86\ kWh - 12.70\ kWh = 0.16\ kWh$

$W = 0.16 \cdot 3.6 \cdot 10^3\ kJ = 576\ kJ$

$$Q = c \cdot m \cdot \Delta\vartheta = 4{,}18 \frac{kJ}{kg \cdot K} \cdot 2\ kg \cdot 68\ K = 568\ kJ$$

Energy is the ability of a body to do work or emit heat.

Once it is turned on, the immersion heater does electric work.

In this experiment, for example, the electrical work W = 576 kJ.

In the heating filament of the immersion heater, electrical energy E_{El} is converted into thermal energy E_{Therm}.

The immersion heater transfers this to the water as an amount of heat Q.

In this experiment, for example, the heat emitted Q = 568 kJ.

The difference between the electrical energy E_{El} and the thermal energy E_{Therm} for the immersion heater is essentially due to the way the experiment is set up.

The thermal energy supplied to the water can escape unhindered into the surroundings (sides of the beaker, air) as heat.

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