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Operating instructions

Fig. 1: Mechanical Equivalent of Heat Apparatus 04440-00

CONTENT

1 SAEFTY PRECAUTIONS

Caution!

- Read the operating instructions thoroughly and completely prior to using this instrument. This is important for your own protection and for avoiding damage to the unit.
- Do not start up this instrument should there be visible signs of damage to it.
- Only use the instrument for the purpose for which it is intended.

2 PURPOSE AND CHARACTERISTICS

The mechanical equivalent of heat equipment provides a method of determining the mechanical equivalent of heat and of determining the specific thermal capacity of a solid body. Mechanical energy from friction is fully converted into thermal energy. As, since 1977, both forms of energy are given in the same units of 1 J = 1 Nm, the mechanical equivalent of heat = 1.

In the experiment a metal test body is rotated and heated by the frictional effect of a tensioned plastic band.

3 SETUP AND HANDLING

The equipment consists of a baseplate with a journal bearing in which the friction cylinder and the crank handle are screwed together with a holder for the friction band.

- Fix the friction cylinder and the crank handle to the journal bearing.
- Hang a spring balance from the holder.
- Attach the friction band to the spring balance.
- Wrap the band 2.5 times areund the cylinder so that the load on the balance is relieved if the crank handle is turned to the right.
- Attach a weight to the lower end of the friction band.
- Fill the hole in the cylinder with thermally conducting paste.

The temperature of the cylinder should be measured before and after a given number of rotations. The hole filled with thermally conducting paste is provided for this purpose. The temperature measurement is most accurate when the thermometer also has contact with the friction cylinder while it is being turned.
The thermometer is held with an angled universal clamp with swivel (Fig. 1).

Caution!

The setup is such that the hole in the cylinder and thermometer are precisely lined up. The baseplate must be clamped firmly with the screw clamps to the table top and must not move when the crank handle is turned. The thermometer may break if the apparatus moves and tilts.

4 PROCEDURE AND EVALUATION

The mass of the friction cylinder should be determined by weighing. A number of rotations, e.g. 1 00, are made with the crank handle as evenly as possible. The spring balance then indicates a constant force F1. The work W due to friction on the cylinder is:

$$W = 2\,\pi \cdot r \cdot n \cdot (F_2 - F_1)$$

n = number of rotations
r = cylinder radius
F_1 = force on the spring balance
F_2 = weight

The work is converted in thermal energy Q.

$$Q = c \cdot m \cdot (T_2 - T_1)$$

m = mass of the friction cylinder
c = specific thermal capacity of the cylinder
T_1 = cylinder temperature at start
T_2 = cylinder temperature at finish

For a known specific thermal capacity for the cylinder material (CuZn: c = 0.385J/gK), the mechanical equivalent of heat W/Q can be found from the measurement.

$$\frac{W}{Q} = 1$$

If it is assumed that $W = Q$, then the specific thermal capacity of solid bodies can be found with this apparatus. The experiment can be carried out with friction cylinders other than that supplied with the apparatus.

Note:
With an aluminium cylinder (Order No. 04441-03) the work due to friction must not be greater than 10 N (weight 1 kg) to avoid severe abrasion of the cylinder which might contaminate the friction band.

Measurement Example:
m = 0.64 kg, r = 2.25 cm, F_1 = 3 N, F_2 = 50 N

n	(T_2-T_1) / °C	W / Q
50	1.4	0.963
100	2.5	1.079
150	4.1	0.986
200	5.2	1.037

Mean value: W / Q = 1.02

5 SCOPE OF DELIVERY

The scope of delivery includes:

- Friction cylinder CuZn, 0,64 kg 04441-01
- Plastic friction tape 04441-04
- Crank handle 04441-05
- Lab thermometer, +15...+40°C 38057-00
- Heat conductive paste, 50 g 03747-00
- G-clamp (2x) 02014-00

6 ACCESSORIES

Necessary accessories:

- Commercial weight, 5000 g 44096-81
- Spring balance, 100 N 03065-07

Holder für thermometer:

- Bench clamp,expert 02011-00
- Universal clamp with joint 37716-00

To determine the specific heat capacity:

- Friction cylinder CuZn, 1,28 kg 04441-02
- Friction cylinder Al, 0.39 kg 04441-03
- Commerical weight 1000 g 44096-70
- Spring balance 10 N 03065-05

7 WARRANTY

We give a warranty of 24 months for units that are supplied by us inside the EU, and a warranty of 12 months outside the EU. The following is excluded from the warranty: damage that is due to non-compliance with the operating instructions, improper use, or natural wear.
The manufacturer can only be held liable for the function and safety-relevant properties of the unit, if the maintenance, service, and modifications of the unit are performed by the manufacturer or by an institution that is expressly authorized by the manufacturer.

8 WASTE DISPOSAL

The packaging mainly consists of environmentally-friendly materials that should be returned to the local recycling stations.

Do not dispose of this product with normal household waste. If this unit needs to be disposed of, please return it to the address that is stated below for proper disposal.

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