P 2.6.2

Hot-air engine: quantitative experiments

P 2.6.2.1 Frictional losses in the hot-air engine (calorific determination)

P 2.6.2.2 Determining the efficiency of the hot-air engine as a heat engine

P 2.6.2.3 Determining the efficiency of the hot-air engine as a refrigerating machine

Frictional losses in the hot-air engine (calorific determination) (P 2.7.2.1)

When the hot-air engine is operated as a heat engine, each engine cycle withdraws the amount of heat Q_1 from reservoir 1, generates the mechanical work W and transfers the difference $Q_2 = Q_1 - W$ to reservoir 2. The hot-air engine can also be made to function as a refrigerating machine while operated in the same rotational direction by externally applying the mechanical work W. In both cases, the work W_F converted into heat in each cycle through the friction of the piston in the cylinder must be taken into consideration.

In order to determine the work of friction W_F in the first experiment, the temperature increase ΔT_F in the cooling water is measured while the hot-air engine is driven using an electric motor and the cylinder head is open.

The second experiment determines the efficiency

$$\eta = \frac{W}{W + Q_2}$$

of the hot-air engine as a heat engine. The mechanical work W exerted on the axle in each cycle can be calculated using the external torque N of a dynamometrical brake which brakes the hot-air engine to a speed f. The amount of heat Q_2 given off corresponds to a temperature increase ΔT in the cooling water.

The final experiment determines the efficiency

$$\eta = \frac{Q_1}{Q_1 - Q_2}$$

of the hot-air engine as a refrigerating machine. Here, the hot-air engine with closed cylinder head is driven using an electric motor and Q_1 is determined as the electrical heating energy required to maintain the cylinder head at the ambient temperature.

388 181	Immersion pump 12 V	1*	1*	1*
521 230	Low voltage power supply	1*	1*	1*
667 194	Silicone tubing, int. dia. 7 x 1.5 mm, 1 m	2*	2*	2*

* additionally recommended

Cat. No.	Description	P 2.6.2.1	P 2.6.2.2	P 2.6.2.3
388 182	Hot-air engine	1	1	1
388 221	Accessories for hot-air engine	1	1	1
347 35	Experiment motor	1		1
347 36	Control unit for experiment motor	1		1
562 11	U-core with yoke		1	
562 12	Clamping device		1	
562 21	Mains coil with 500 turns for 230 V		1	
562 18	Extra-low voltage coil, 50 turns		1	
521 35	Variable extra-low voltage transformer S			1
575 471	Counter S	1	1	1
337 46	Forked light barrier, infra-red	1	1	1
501 16	Multi-core cable, 6-pole, 1.5 m	1	1	1
531 100	Multimeter METRAmax 2		1	1
531 712	Multimeter METRAmax 3		1	1
313 17	Stopclock II, 60 s/30 min	1	1	1
314 141	Precision dynamometer, 1.0 N		1	
382 36	Thermometer, -10° to + 40 °C	1	1	1
300 02	Stand base, V-shape, 20 cm	1	2	1
300 41	Stand rod, 25 cm	1	1	1
300 42	Stand rod, 47 cm		1	
300 51	Stand rod, right-angled		1	
301 01	Leybold multiclamp		2	
590 06	Plastic beaker, 1000 ml	1	1	1
342 61	Set of 12 weights, 50 g each		1	
501 33	Connecting lead, Ø 2.5 mm², 100 cm, black		3	3
501 45	Pair of cables, 50 cm, red and blue		1	1