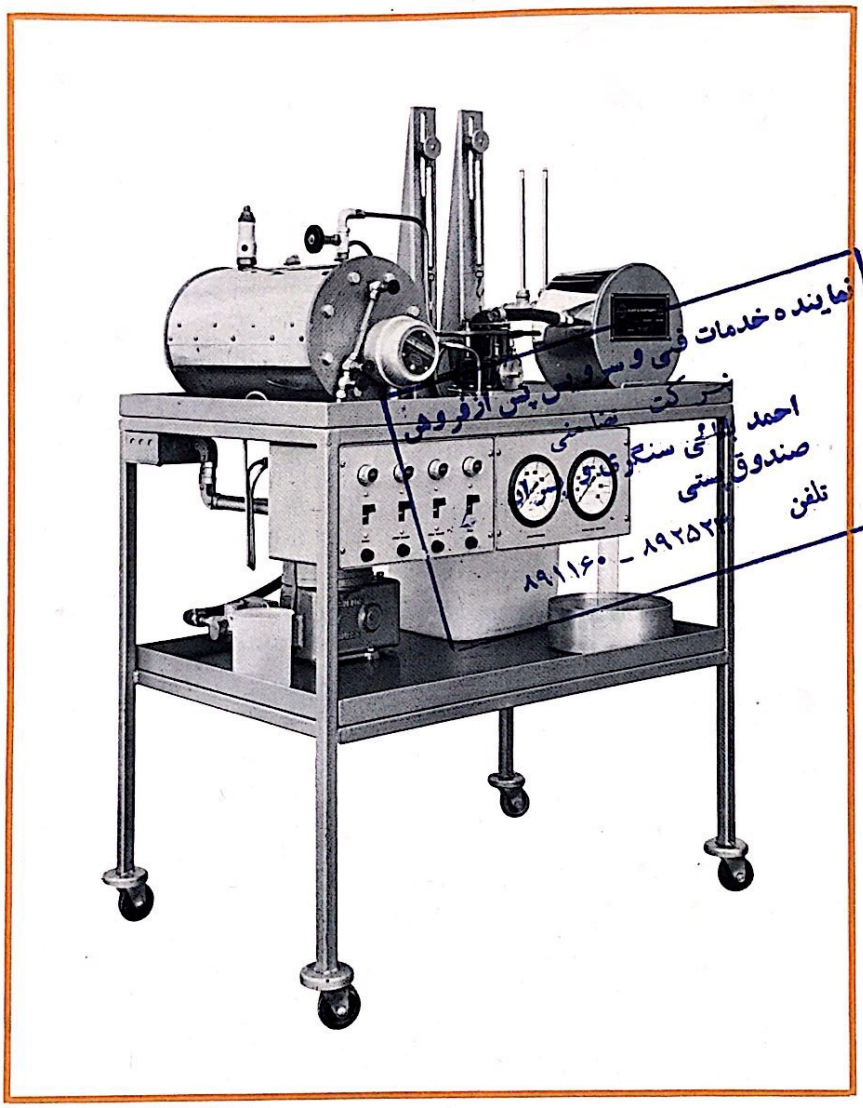
PLINT ENGINEERS TE 5

Instructional Equipment for Engineering

STEAM MOTOR & ENERGY CONVERSION TEST SET



1 General

The steam cycle retains its importance in the education of engineers. A steam plant still forms the best means of demonstrating in the laboratory many important thermodynamic principles, including the First and Second Laws, the Steady Flow Energy Equation, and the concepts of the control surface and of thermal efficiency.

At an elementary level a steam plant forms an excellent introduction to experiments of an engineering kind, demonstrating such fundamentals as the conversion of energy from one form to another and the measurement of mechanical power.

A disadvantage of the instructional steam plants previously available has been their large size and cost, and the necessity for expensive permanent foundations, pipework and services. With the present unit these are limited to a supply of electricity and cooling water. A further feature of the unit is that unlike conventional steam power plants it may safely be placed in the hands of relatively inexperienced students with the minimum of supervision.

2 Technical Data

Steam Motor: Totally enclosed, two-cylinder, single-acting, trunk piston.
Bore and stroke: 25.4 mm x 25.4 mm.
Nominal output: 120W at 2000 rev/min.
Maximum steam consumption: 8kg/hour.
Maximum cooling water flow: 150 litres/hour.
Maximum steam pressure: [illegible] N/m².
Electrical power consumption: 6kW.
Overall Dimensions: 96 cm x 66 cm x 138 cm high.
Net Weight: 128 kg.

3 Description

The Steam Motor Test Set incorporates as prime mover a small totally enclosed high-speed steam motor of modern design, manufactured by Stuart-Turner Limited of Henley-on-Thames. The motor, which is splash lubricated, has a totally-enclosed crank case, cast iron trunk pistons with cast iron rings and an overhead piston valve driven by way of bevel gears and a vertical shaft. The power output, amounting to a maximum of about 140 Watts, is absorbed by a simple band brake bearing against the fly-wheel and attached to two spring balances, supported by adjustable stands.

The boiler, of steel, incorporates two electrical immersion heaters of 3 kW capacity and is provided with a safety valve, water level gauge, and blow down cock. The heaters incorporate thermal cut-outs which operate to prevent damage should the water level in the boiler fall below the recommended minimum.

The boiler is supplied with water by an electric motor-driven reciprocating feed pump which draws its supply from a plastic feed water tank.

The steam exhausted from the motor is led to an atmospheric condenser containing a cooling coil, which must be supplied with mains water. The condensed steam is led away either to waste or to a measuring cylinder.

The electrical controls, comprising an isolator, indicator lamps and switches for the two heaters and for the feed pump are carried in a cabinet below the working surface of the apparatus.

The complete apparatus is supported on a tubular steel trolley running on castors. Services required comprise an electrical supply which may be taken by way of flexible conduit, a supply of cooling water by way of a flexible hose, and access to a drain for the cooling water and condensate discharge.

A schematic diagram of the system is shown in Figure 2.

4 Instrumentation

Standard instrumentation comprises:
Spring balances for torque measurement;
Pressure gauges for boiler and motor inlet pressures;
Thermometers for boiler steam temperature and cooling water inlet and outlet temperature;

An electronic tachometer is supplied for the measurement of motor speed.

Measuring cylinder for condensate flow.

A watthour meter for measurement of electrical power input may be supplied as an optional extra.

5 Experiments

A selection of experiments that may be carried out with the apparatus is as follows:

(a) The well-known "Marcet Boiler" experiment for determining the relationship between pressure and temperature of saturated steam. Figure 3 shows typical test results.
(b) A study of the performance of the high-speed steam motor. Figure 4 shows performance characteristics.
(c) The application of the First Law of Thermodynamics to the analysis of the performance of a complete steam plant. Figure 5 shows the energy balance for the boiler, engine, and condenser.

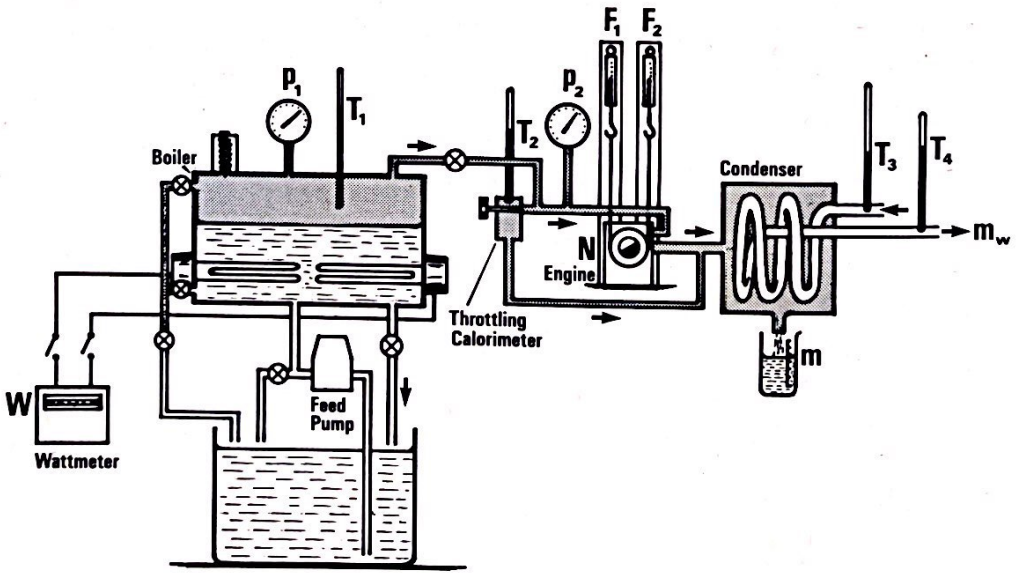


Figure 2 Schematic Diagram

(d) As elements of the last experiment, a test of a steam boiler and a condenser.
(e) Application of the Second Law of Thermodynamics in a form of a Rankine Cycle analysis of the performance of a steam plant, see Figure 6.

6 Throttling Calorimeter
As an optional extra, a throttling calorimeter for the measurement of dryness fraction may be provided.

7 Services
A Water Supply of 150 litres/hr. is required.
For customers with a 50 Hz electrical supply only 1 Phase, 6 kW is required. However for a 60 Hz supply a 3 Phase, 6 kW supply is necessary. Please state your supply when ordering.

Order as:
*TE5 Steam Motor Te Set
*TE5/C Throttling Calorimeter
*RE26 Watthour Meter

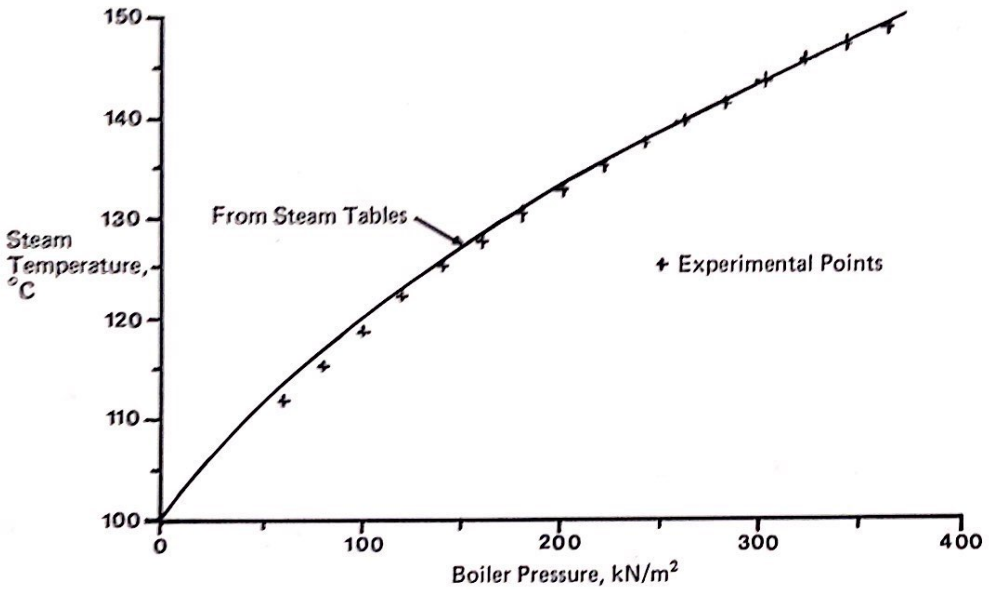


Figure 3 Pressure-Temperature Relationship for Saturated Steam

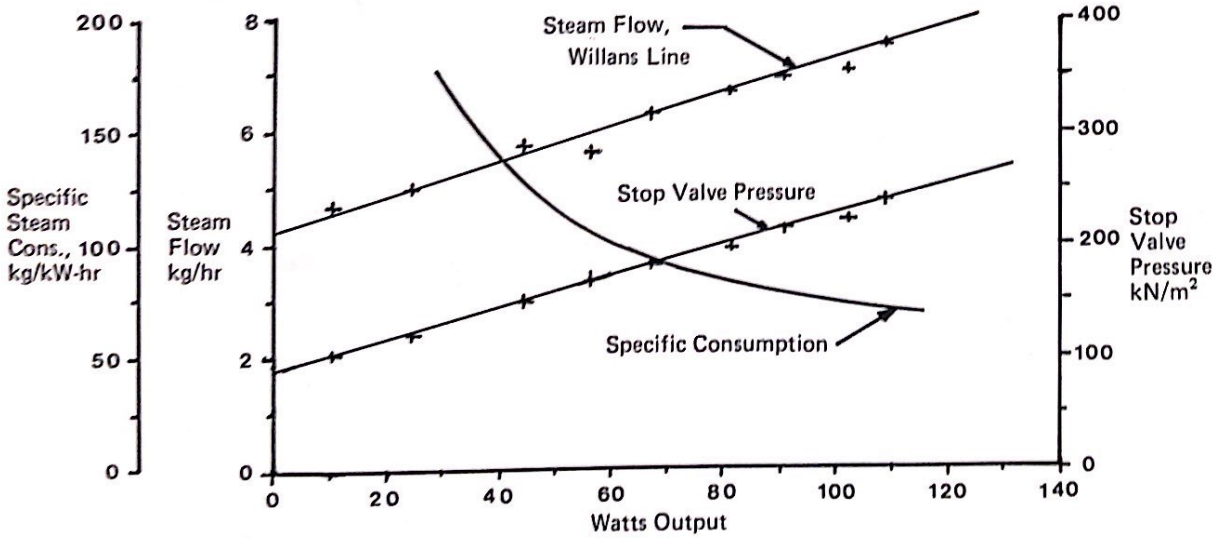


Figure 4 Performance Curves for Steam Motor

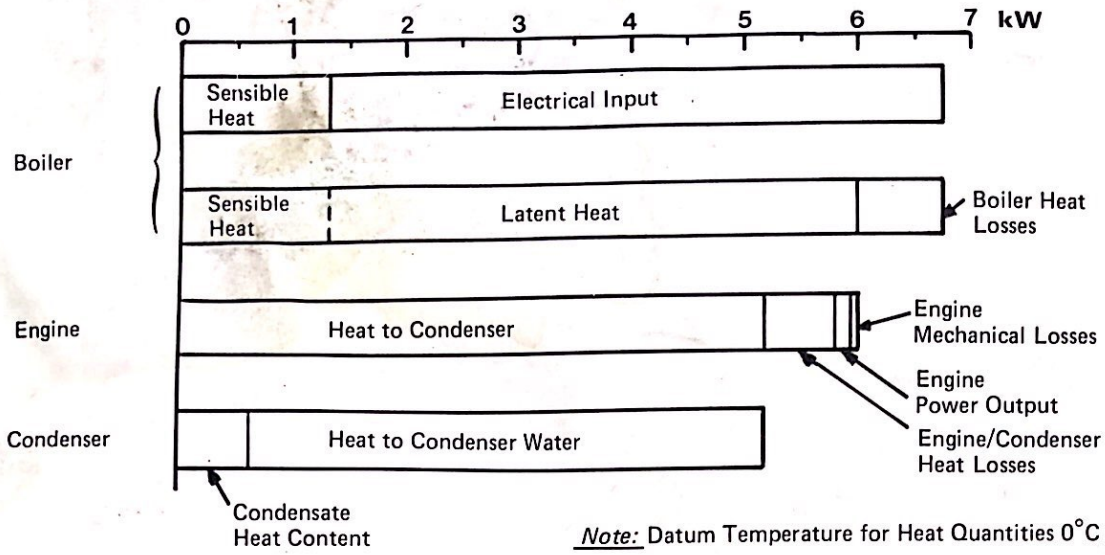


Figure 5 Energy Balance for Steam Plant

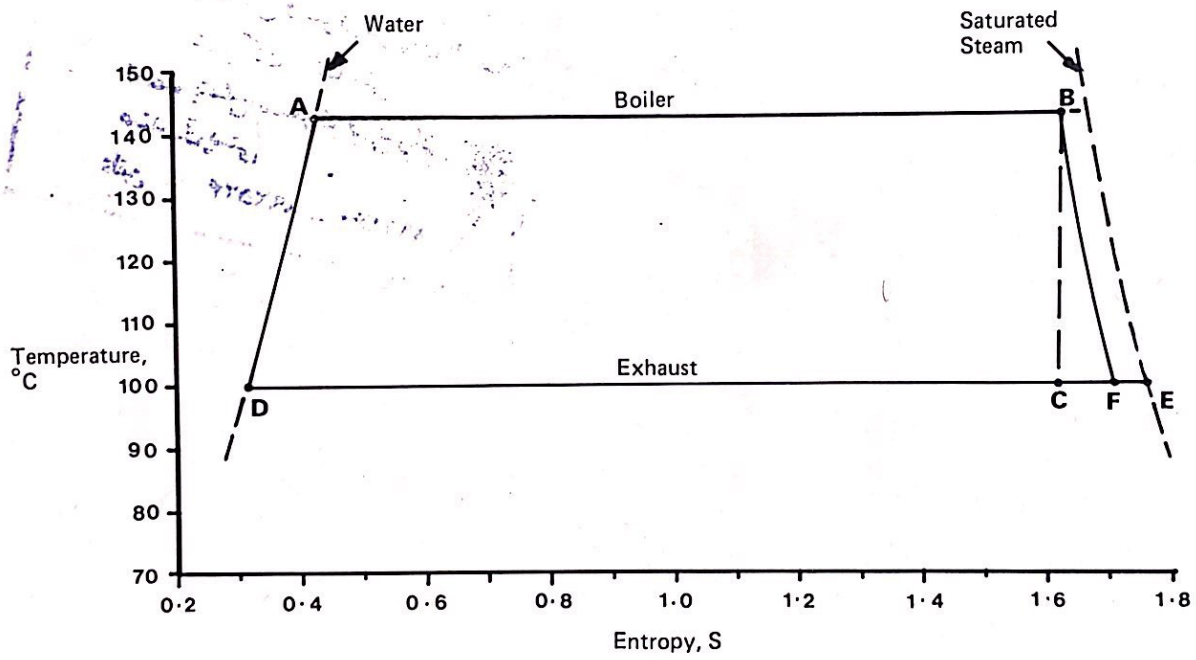


Figure 6 Temperature-Entropy Diagram for Steam Plant

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