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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Automatic steam traps — Determination of steam loss — Test methods

Purgeurs automatiques de vapeur d'eau — Détermination de la perte de vapeur — Méthodes d'essai

Reference number
ISO 7841 : 1988 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7841 was prepared by Technical Committee ISO/TC 153, *Valves.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Automatic steam traps — Determination of steam loss — Test methods

1 Scope and field of application

This International Standard specifies two test methods to determine the steam loss of automatic steam traps to ISO 6552.

The object of these tests is to determine the amount of live steam, if any, that is lost through the steam trap. They are, therefore, tests to evaluate the ability of the traps to shut against steam during successive operations.

There is no measurement of the total heat energy lost by the trap. Such total heat loss would include radiation and convection components which can be established separately.

2 References

ISO 651, *Solid-stem calorimeter thermometers.*

ISO 652, *Enclosed-scale calorimeter thermometers.*

ISO 653, *Long solid-stem thermometers for precision use.*

ISO 4185, *Measurement of liquid flow in closed conduits — Weighing method.*

ISO 6552, *Automatic steam traps — Definition of technical terms.*

3 Test arrangements

The test arrangements for steam loss determination are shown in figures 1 and 2. The minimum water capacity of the calorimeter tank (see figure 1) shall be 0,02 m^3. It is most important that the condensate drainage device be fully capable of maintaining a dry line to the heat exchanger. The test device shall be located sufficiently below the heat exchanger to prevent condensate backing up into the heat exchanger, should the test device only operate infrequently.

All piping and equipment (including the heat exchanger) shall be insulated to a value of

$$R \geqslant 0{,}75 \times 10^{-3} \frac{m^2 \cdot {}^\circ C \cdot h}{J}$$

to reduce thermal losses to a minimum.

The instruments used for the measurements shall comply with International Standards, if such standards exist, e.g.

— ISO 651, ISO 652, ISO 653 for temperature measurements;

— ISO 4185 for flow measurements.

The condensate removal device shall not be modified in any way from its commercial form.

4 Test method A

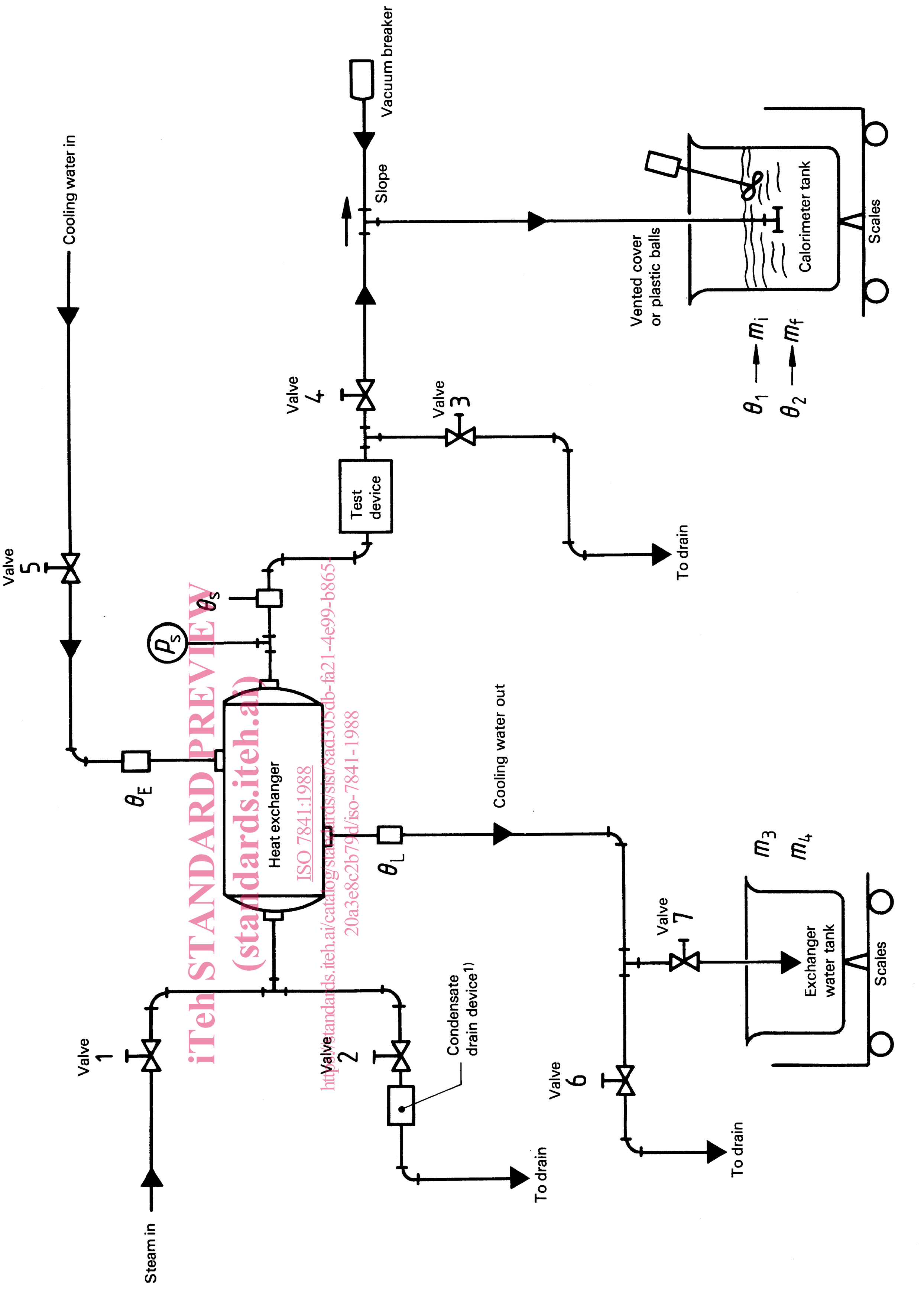

Figure 1 — Test arrangement for steam loss tests with test method A

1) Operating at steam temperature.

The test may be carried out at a pressure corresponding to the maximum working pressure of the trap, the test pressure not exceeding 32 bar[1)] with saturated steam (238 °C).

Load testing shall be carried out at 1 % of the maximum capacity of the trap at the corresponding test pressure with a minimum of 5 kg/h.

4.1 Procedure

4.1.1 No-load condition

Start with all valves closed and tanks empty.

4.1.1.1 Open valves 1, 2 and 3 to permit the drain and test devices to operate at test pressure p_s.

4.1.1.2 During warm-up, weigh and record the mass of the empty calorimeter tank m_t, and record the steam pressure p_s and steam temperature θ_s.

4.1.1.3 Fill the calorimeter tank with sufficient water (about half-full) to result in a test run of practical duration. The initial water temperature θ_1 should be at least 8 °C below ambient temperature θ_a. Record the water temperature θ_1 and mass of water plus tank m_1.

4.1.1.4 When thermal equilibrium is reached, simultaneously and rapidly close valve 3, open valve 4, and start the timing interval. The use of a three-way valve is recommended to facilitate rapid closing and opening.

4.1.1.5 Stir the water in the tank as necessary to ensure a uniform water temperature.

4.1.1.6 When the temperature of the water in the tank is as many degrees above ambient as the initial temperature was below, rapidly close valve 4 and open valve 3 simultaneously, record the elapsed time, the final water temperature θ_2 and the mass of water plus tank m_2.

4.1.1.7 Before the measurement, trial runs should be carried out to ensure that the test conditions have stabilized and that the pressure, temperature, initial amount of water in the calorimeter tank and load conditions are those required. When testing condensate removal devices, an error calculation is made from three consecutive tests to determine the accuracy of the test result. The error calculation is based on the instrumentation used and described in this International Standard; or the average result from three consecutive tests shall agree within 10 % or 500 g/h, whichever is the greater.

If this cannot be obtained, check the system for integrity and increase the calorimeter tank capacity.

4.1.2 Load condition

Start with all valves closed and both tanks empty.

4.1.2.1 Open valves 1, 2 and 3 to permit the drain and test devices to operate at test pressure p_s.

4.1.2.2 During warm-up, weigh and record the mass of the empty calorimeter tank m_t, and record the steam pressure p_s and steam temperature θ_s.

4.1.2.3 Open valves 5 and 6 to allow a flow of cooling water through the heat exchanger, to create the desired condensate load on the test device. After the system has come to equilibrium, this load can be determined by closing valve 6 and opening valve 7, to permit a known amount of water to be collected in a given time.

Record the temperature of water entering and leaving the heat exchanger, θ_E and θ_L, the initial and final mass of exchanger water plus tank, m_3 and m_4, and the time Δt, in seconds, of run on the Data Sheet in 4.3. The approximate condensate load, in kilograms per hour, on the trap may then be calculated using the formula

$$\text{Load} = \frac{(\theta_L - \theta_E)(m_4 - m_3) \times 3\,600}{\Delta t \cdot h_{fgs}}$$

where h_{fgs} is the specific enthalpy of the evaporation at steam inlet conditions, in joules per kilogram.

4.1.2.4 If the load on the trap as determined in 4.1.2.3 is as desired, proceed to 4.1.2.5. If it is not as desired, adjust valve 5 accordingly and repeat the procedure in 4.1.2.3 until the desired load is obtained.

4.1.2.5 Fill the calorimeter tank with sufficient water (about half-full) to result in a test run of practical duration. The initial water temperature θ_1 should be at least 8 °C below ambient temperature θ_a. Record the water temperature θ_1 and mass of water plus tank m_1.

4.1.2.6 When thermal equilibrium is reached, simultaneously and rapidly close valve 3, and open valve 4, and start the timing interval. The use of a three-way valve is recommended to facilitate rapid closing and opening.

4.1.2.7 Stir the water in the calorimeter tank as necessary to ensure a uniform water temperature.

4.1.2.8 When the temperature of the water in the calorimeter tank is as many degrees above ambient as the initial temperature was below, rapidly close valve 4 and open valve 3 simultaneously, record the elapsed time, the final water temperature θ_2 and the mass of water plus tank m_2.

4.1.2.9 Before the measurement, trial runs should be carried out to ensure that the test conditions have stabilized and that the pressure, temperature, initial amount of water in the calorimeter tank and load conditions are those required. When testing condensate removal devices, an error calculation is made from three consecutive tests to determine the accuracy of the test result. The error calculation is based on the instrumentation used and described in this International Standard; or the average result from three consecutive tests shall agree within 10 % or 500 g/h, whichever is the greater.

1) 1 bar = 10^5 Pa

If this cannot be obtained, check the system for integrity and increase the calorimeter tank capacity.

4.2 Expression of results

4.2.1 Correction of measured variables

The values of observed variables shall be corrected in accordance with instrument calibrations and, if necessary, converted to the proper units required for calculations.

4.2.2 Use of formula symbols

The symbols used in this International Standard are the ones normally associated with engineering practice in this field. In a few cases, the same symbol has different meanings in different parts of this International Standard according to its application. In order to avoid confusion, each formula has been provided with its own list of definitions of symbols and units.

4.2.3 Computation formula

$$q_{ms} = \left[\frac{m_f h_{f2} - m_i h_{f1} - h_{fs}(m_f - m_i) + c_p m_t (\theta_2 - \theta_1)}{h_{fgs}}\right] \times \frac{3\,600}{\Delta t}$$

where

q_{ms} is the steam loss, in kilograms per hour;

m_i is the initial mass of water in the calorimeter, in kilograms;

m_f is the final mass of water and condensate in the calorimeter, in kilograms;

m_1 is the mass of calorimeter plus water, at the start, in kilograms;

m_2 is the mass of calorimeter plus water, at the finish, in kilograms;

m_t is the mass of calorimeter tank, in kilograms;

h_{f1} is the initial specific enthalpy of water in the calorimeter, in joules per kilogram;

h_{f2} is the final specific enthalpy of the condensate and water in the calorimeter, in joules per kilogram;

h_{fs} is the specific enthalpy of the liquid at steam inlet conditions, in joules per kilogram;

h_{fgs} is the specific enthalpy of the evaporation at steam inlet conditions, in joules per kilogram;

c_p is the specific heat of the calorimeter material, in joules per kilogram kelvin;

θ_1 is the initial water temperature in the calorimeter tank, in degrees Celsius;

θ_2 is the water temperature in the calorimeter tank, in degrees Celsius;

Δt is the time interval, in seconds.

4.3 Data sheet

Test Method A

General information

1 Test No. .... **2** Test date : .... **3** Location : ....

4 Manufacturer's name : .... **5** Serial No. : ....

6 Type of device : .... **7** Size : ....

8 Calorimeter material : ....

9 Mass of empty calorimeter, m_t = ...

Averaged and corrected test data

10 Mass of calorimeter plus water, start, m_1 = ... kg

11 Mass of calorimeter plus water, finish, m_2 = ... kg

12 Mass added to calorimeter, Δm = ... kg
Item 11 – Item 10

13 Time interval, Δt = ... s

14 Ambient temperature, θ_a = ... °C

15 Steam temperature at trap inlet, θ_s = ... °C

16 Initial water temperature in calorimeter tank, θ_1 = ... °C

17 Final temperature of water and condensate in calorimeter tank, θ_2 = ... °C

18 Barometric pressure, p_a = ... bar

19 Steam pressure at trap inlet, p_s = ... bar

Thermodynamic properties

20 Reference used for specific heat data : ....

21 Reference used for steam/water data : ....

22 Specific heat of calorimeter material, c_p = ... J/(kg·K)
(from Item 20 for Item 8 at average of Items 16 and 17)

23 Initial specific enthalpy of water in calorimeter, h_{f1} = ... J/kg
(from Item 21 at Item 16)

24 Final specific enthalpy of water in calorimeter, h_{f2} = ... J/kg
(from Item 21 at Item 17)

25 Specific enthalpy of saturated liquid at trap inlet temperature, h_{fs} = ... J/kg
(from Item 21 at Item 15)

26 Specific enthalpy of evaporation at trap inlet temperature, h_{fgs} = ... J/kg
(from Item 21 at Item 15)

Calculations

27 Initial mass of water in calorimeter, m_i = ... kg
Item 10 – Item 9

28 Final mass of water and condensate in calorimeter, m_f = ... kg
Item 11 – Item 9

29 Initial enthalpy of water in calorimeter tank, $m_i h_{f1}$ = ... J
(Item 27) × (Item 23)

30 Final enthalpy of water and condensate in calorimeter tank, $m_f h_{f2}$ = ... J
(Item 28) × (Item 24)

31 Enthalpy of condensate added to calorimeter tank, $h_{fs}(m_f - m_i)$ = ... J
(Item 25) × (Item 28 − Item 27)

32 Enthalpy difference of calorimeter tank, $c_p m_t (\theta_2 - \theta_1)$ = ... J
(Item 22) × (Item 9) × (Item 17 − Item 16)

33 Steam loss, q_{ms} = ... kg/h

$$\frac{\text{Item 30} - \text{Item 29} - \text{Item 31} + \text{Item 32}}{\text{Item 26}} \times \frac{3\,600}{\text{Item 13}}$$

34 Water discharged with steam, q_{mw} = ... kg/h

$$\frac{(\text{Item 12}) \times 3\,600}{\text{Item 13}} - \text{Item 33}$$

35 Load . . . . kg/h

5 Test method B

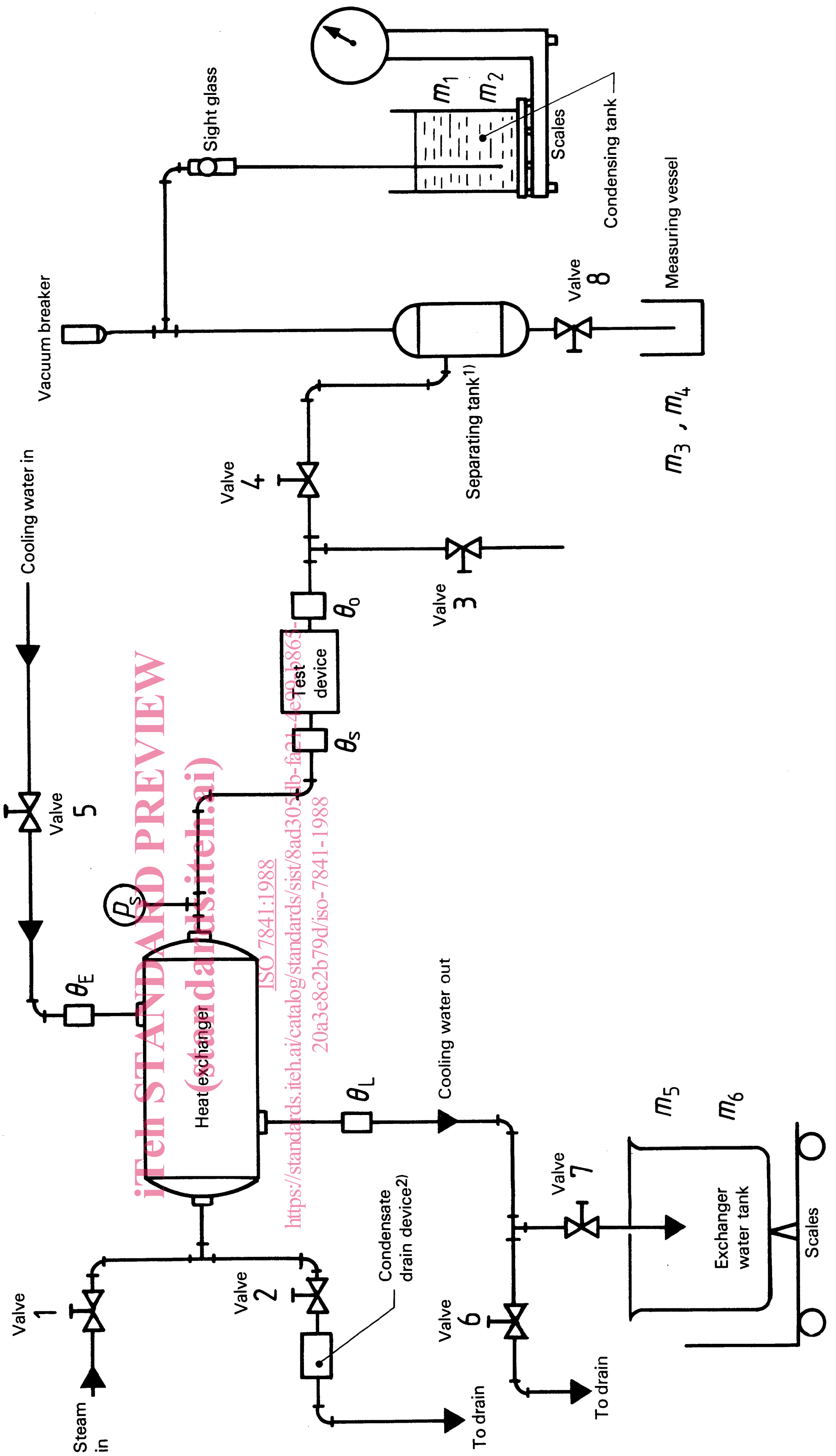

Figure 2 — Test arrangement for steam loss tests with test method B

1) The separating tank should be kept hot by a heated jacket or an insulating system.

2) Operating at steam temperature.