BRITISH STANDARD

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Oil fired forced convection air heaters — Stationary and transportable for space heating

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ICS 97.100.40

National foreword

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The UK participation in its preparation was entrusted to Technical Committee RHE/10, Heating boilers, which has the responsibility to:

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— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

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English version

Oil fired forced convection air heaters - Stationary and transportable for space heating

Générateurs d'air chaud à convection forcée fonctionnant au fioul domestique - Fixes et transportables pour le chauffage des locaux

Ölbefeuerte Warmlufterzeuger - Ortsfest und ortsbeweglich für die Raumheizung

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Contents

Foreword

This document (EN 13842:2004) has been prepared by Technical Committee CEN/TC 57 “Central heating boilers”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2005, and conflicting national standards shall be withdrawn at the latest by January 2005.

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1 Scope

This document specifies the requirements and test methods for the safety and efficiency of oil-fired air heaters using only forced draught oil burners, hereafter referred to as “appliances”.

This document applies to stationary and portable appliances. It also applies to appliances intended for outdoor installation. Provision of the heated air may be by means of ducting or may be directly into the heated space.

For the purpose of this document the heat generation is by the combustion of liquid fuel oils as defined in EN 267 (gas oil with a viscosity at the burner inlet of 1,6 mm²/s (cSt) up to 6 mm²/s (cSt) at 20 °C). Alternatively, if the manufacturer requests, the fuel of kerosene may be used as defined in EN 304. Kerosene with a viscosity at the burner of 1,3 mm^2/s (cSt) to 2,9 mm^2/s (cSt) at 20 °C) or other suitable liquid fuel oils may also be used.

This document does not apply to:

— appliances intended for use in a single unit residential dwelling;

— appliances of the condensing type;

— appliances with atmospheric burners without a fan to assist the transportation of combustion air;

— dual purpose air conditioning appliances (heating and cooling);

— appliances where the air is heated by an intermediate fluid;

— appliances fitted with manual or automatic flue dampers;

— appliances having multiple heating units with a single flue;

— appliances fitted with more than one flue outlet.

This document is applicable to appliances which are intended to be type tested.

NOTE Requirements for appliances which are not type tested would need to be subject to further consideration.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 230, *Monobloc oil burners — Safety, control and regulation devices and safety times.*

EN 267, *Forced draught oil burners — Definitions, requirements, testing, marking.*

EN 304:1992, *Heating boilers — Test code for heating boilers for atomizing oil burners.*

prEN 50156-1, *Electrical equipment for furnaces and ancillary equipment — Part 1: Requirements for application design and installation.*

EN 60335-1:2002, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1:2001, modified).*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989*).

EN 60730-2-1, *Automatic electrical controls for household and similar use — Part 2: Particular requirements for electrical controls for electrical household appliances (IEC 60730-2-1:1989, modified).*

EN 60730-2-9, *Automatic electrical controls for household and similar use — Part 2-9: Particular requirements for temperature sensing controls (IEC 60730-2-9:2000, modified).*

EN ISO 1182:2002, *Reaction to fire tests for building products - Non-combustibility test (ISO 1182:2002)*.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Appliance and its constituent parts

3.1.1
stationary air heater
fixed appliance designed for the heating and possibly ventilation of a building

3.1.2
forced convection air heater
appliance designed to provide space heating from a central source by distributing heated air, by means of an air moving device, either through ducting or directly into the heated space.

The appliance may consists of the following components:

— combustion chamber;

— heat exchanger;

— fan with drive motor;

— housing (casing);

— air control device;

— integrated oil burner or atomising oil burner of the monobloc-type according to EN 267.

The appliance may consist of several assemblies which are joined together

3.1.3
portable warm air heaters
appliance with a heat exchanger in accordance with 3.1.2 but designed to be portable or moveable. It may contain a built-in fuel tank

3.1.4
oil burner
burner that is intended to assure the thermal function of the appliance and is generally called the burner

3.1.5 Combustion products circuit

3.1.5.1
combustion chamber
enclosure inside which combustion of the air-fuel mixture takes place

3.1.5.2
heat exchanger
part of the appliance designed to transfer heat from the combustion products to the transport air

3.1.5.3
flue outlet
part of the appliance that connects with a flue to evacuate the products of combustion

3.2 Adjusting, control and safety devices

3.2.1
automatic burner control system
system comprising automatic start and stop sequencing flame detector device and flame supervision

NOTE See also EN 230

3.2.2
automatic shut-off valve
valve designed to open the fuel supply to the burner when energised and to close automatically when de-energised

3.2.3
control thermostat
device controlling the operation of the appliance (by on/off, high/low or modulating control) and enabling the temperature to be kept automatically, within a given tolerance, at a predetermined value

3.2.4
overheat cut-off device
device that shuts off and locks out the fuel supply to the burner when the temperature of the delivered air exceeds a certain pre-set value, and that requires manual intervention to restore the fuel supply. This should be before the appliance is damaged and/or before safety is put into question. This device is pre-set and sealed by the manufacturer (see 4.8.3.2)

3.2.5
fan delay control
control that starts and/or stops the air delivery fan when the temperature of the delivered air reaches a certain predetermined value

3.2.6
temperature sensing element; temperature sensor
component that detects the temperature of the environment to be supervised or controlled

3.2.7
modulating control
automatic control by which the heat input of the appliance can be varied in a continuous manner between the nominal heat input and a minimum value

3.2.8
high/low control
automatic control which permits an appliance to operate either at the nominal heat input or at a fixed reduced heat input

3.3 Operation of the appliance

3.3.1
volumetric flow rate
volume of fuel consumed by the appliance in unit time during continuous operation

Symbol: V

NOTE Litres per hour (l/h), cubic decimetres per hour (dm^3/h).

3.3.2
mass flow rate
mass of fuel consumed by the appliance in unit time during continuous operation

Symbol: m

NOTE Kilograms per hour (kg/h).

3.3.3
heat input
quantity of energy used in unit time corresponding to the volumetric or mass flow rates, the calorific value to be used being the net calorific value

Symbol: Q_0

NOTE Kilowatts (kW).

3.3.4
nominal heat input
value of heat input declared by the manufacturer

Symbol: Q_N

NOTE Kilowatts (kW).

3.3.5
nominal heat output
value of heat output declared by the manufacturer, which is the time related quantity of heat transferred to the delivered air.

It is calculated as the heat input less the heat lost to the products of combustion leaving the flue

Symbol: Q

NOTE Kilowatts (kW).

3.3.6
delivered air volume
time related volume of air leaving the appliance corrected to standard conditions of absolute pressure 1 013,25 mbar and temperature of 15 °C

NOTE Cubic metres per second (m^3/s) or cubic metres per hour (m^3/h).

3.3.7
delivered air pressure
static pressure available within the duct system provided by the appliance fan related to the delivered air volume

NOTE Pascal's (Pa) or millibar (mbar); 1 Pa = 1 N/m^2; 1 mbar = 100 N/m^2.

3.3.8
controlled shut-down
process where the power to the fuel shut off valves and/or the burner motor is removed immediately, e.g. as a result of the action of a controlling function

3.3.9
safety shut-down
process which is effected immediately following the response of a safety limiter or sensor or detection of a fault in the burner control system and which puts the burner out of operation by immediately removing the power to the fuel shut-off valves, the ignition device and/or the burner motor

3.3.10
lock-out
safety shut-down condition of the system, such that a restart can only be accomplished by a manual reset of the system and by no other means

3.3.11
running condition of the system
condition in which the burner is in normal operation under the supervision of the programming unit and its flame detector

3.4 Conditions of operation and measurement

3.4.1
cold condition
condition of the appliance required for some tests and obtained by allowing the unlit appliance to attain thermal equilibrium at room temperature

3.4.2
hot condition
condition of the appliance required for some tests and obtained by heating to thermal equilibrium at the nominal heat input specified by the manufacturer, any thermostat remaining fully open

3.4.3
equivalent resistance
resistance to flow in millibars, measured at the outlet of the appliance, which is equivalent to that of the actual flue

Units: Pascal (Pa), Millibar (mbar)

3.5
Reference conditions
- for calorific values, temperature 15 °C;

- for fuel and air volumes dry, brought to 15 °C and absolute temperature of 1 013,25 mbar.

4 Requirements of construction

4.1 General

When the appliance is installed in accordance with the manufacturer's instructions, all components, including the heat exchanger, shall withstand the mechanical, chemical and thermal conditions to which they may be subjected in the course of normal use.

If condensation occurs, this shall not affect the operational safety. With the exception of the outlet of the flue system, any condensate formed shall not drop outside the appliance.

Asbestos or materials containing asbestos shall not be used.

Solder that contains cadmium shall not be used.

Where appropriate, materials used on the appliance shall be non-combustible in accordance with the requirements of EN ISO 1182.

4.2 Accessibility for maintenance and use

Parts that are intended to be removable for maintenance or cleaning shall be readily accessible and capable of correct assembly and difficult to assemble incorrectly. Such parts shall be impossible to assemble incorrectly where incorrect assembly would create a hazardous condition or result in damage to the appliance and its controls.

Access shall be possible to all handles, buttons etc. required during normal use of the appliance, without having to remove any part of the case. For this purpose, the opening of a door or access panel is permitted.

Constructional parts accessible during use and maintenance shall be free from sharp edges and corners that might cause damage or personal injury during use or maintenance.

The products of combustion shall not be drawn into the air distribution system when user access panels are removed.

4.3 Insulation

Any thermal insulation shall retain its insulating properties under the influences of heat and ageing. The insulation shall withstand the normally expected thermal and mechanical stresses. Should any acoustic insulation be fitted to the appliance it shall be at least flame retardant.

4.4 Supply of combustion air and evacuation of combustion products

4.4.1 General

All appliances shall be designed so that there is an adequate supply of combustion air during ignition and operation over the whole range of possible heat inputs stated by the manufacturer.

4.4.2 Appliance combustion products outlet

The cross-section of the appliance combustion products outlet shall not be adjustable.

The combustion products outlet shall be female and shall allow, if necessary by means of an adapter supplied with the appliance, connection to a flue pipe whose diameter complies with the standards in force where the appliance is to be installed.

The internal diameter of the combustion products outlet shall be such as to ensure compliance with requirements concerning operation.

It shall be possible to insert a flue pipe of nominal external diameter (D – 2) mm to a depth of at least D/4 but not so far that the evacuation of the combustion products is impaired. However, for a vertical connection, the depth of insertion can be reduced to 15 mm for an appliance with heat input up to 70 kW and 25 mm for an appliance with heat input exceeding 70 kW.

NOTE D is the outside diameter of the duct.

4.5 Electrical equipment

For the electrical equipment and connections of the burner the following requirements of prEN 50156-1 and EN 60335-1 shall apply:

a) rated value;

b) protection against accessibility to live parts;

   1) leakage current and electric strength;

   2) internal wiring;

   3) components;

   4) supply connection and external flexible cords;

   5) connection terminals for external conductors;

6) provision for earthing;

7) creepage distances, clearances and distances through insulation;

c) radiation;

1) resistance to heat, fire and tracking.

The leakage current and electrical strength tests on the complete burner need not be performed if the components and sub-assemblies have been separately tested and the interconnection is carried out in accordance with the manufacturer's instructions.

If the measurements of the leakage current as required in EN 60335-1:2002, 13.2, are not possible, because the circuits of protective impedance or radio interference filters cannot be disconnected, then the leakage limit specified for leakage current is to be calculated taking into account the current through those circuits.

NOTE For industrial application, see EN 60204-1.

In addition the documentation of the electrical connections for the individual components shall be provided by means of an electrical wiring and connection diagram.

If the appliance is fitted with electronic components or electronic systems providing a safety function, these shall comply with the relevant requirements of EN 230 with regard to electromagnetic compatibility immunity levels.

If the manufacturer specifies the nature of the electrical protection of the appliance on the data plate, this specification shall comply with EN 60529:

— to give the degree of personal protection against contact with dangerous electrical components inside the appliance case;

— to give the degree of electrical protection, inside the appliance case, against harmful actions due to water penetration.

4.6 Operational safety

The fluctuation of, or the interruption and subsequent restoration of the electricity supply at any time during the starting up or operation of the appliance shall result in continued safe operation, or safety shut-down (lockout).

Interruption and subsequent restoration of the electricity supply shall not override any lock-out condition.

4.7 Motors and fans

The direction of rotation of fans shall be clearly marked.

Motors and fans, including any belt drives, shall be protected by suitable guards, shields or screens of adequate size, strength and durability so that they are not liable to be touched (see also EN 60529, class IP 20). Removal of such guards, shields or screens shall be possible only with the use of tools.

Where necessary, means shall be provided to facilitate the adjustment of the belt tension by the use of tools.

4.8 Adjusting, control and safety devices

4.8.1 General

The functioning of any safety device shall not be overruled by that of any control device.

All controls and safety devices shall be appropriate for use over the range of ambient temperatures declared by the appliance manufacturer.

When there are several control knobs (taps, thermostats, etc.), they shall not be interchangeable if this could lead to confusion or they shall be clearly marked to identify their function.

4.8.2 Facility for remote control

4.8.2.1 General

Where the appliance is capable of being controlled remotely by means of thermostats or a time control, electrical connections of these controls shall be possible without disturbing any internal connections in the appliance other than a link exclusively designed for this purpose. When the heater is installed in accordance with the manufacturer's instructions, no hazardous condition shall occur as a result of failure of the normal means of air temperature control.

Thermostats and control of air temperature.

4.8.2.2 General requirements

Electrical thermostats shall comply with the requirements of EN 60730-2-1.

Overheat cut-off devices shall comply with Type 2K requirements of EN 60730-2-9.

4.8.2.3 Overheat cut-off device

An overheat cut-off device shall be fitted to the appliance to cause shut-down and non-volatile lock-out in the event of an overheat condition occurring.

The operating temperature of the overheat device shall be set and sealed by the manufacturer.

The lock-out action shall not rely on the operation of the flame detection circuits. In particular, the device shall not be wired in series with either the flame sensor or the line supply from a programming unit to any automatic shut-off valve.

This device shall not operate during the normal operation of the appliance.

4.8.3 Fan delay controls

4.8.3.1 Delayed start

Where means are provided to delay the operation of the air delivery fan after ignition of the burner to prevent the discharge of cold air into the heated space, the fan start delay shall not be such as to cause the overheat device(s) to operate under normal conditions.

4.8.3.2 Delayed shut-down

Means shall be provided to delay the shut-down of the air delivery fan after shut-down of the burner(s).

4.8.4 Sensors

Control thermostats and overheat cut-off devices may have the same sensor if failure of the sensor results in lock-out of the appliance.

4.9 Combustion chamber pressure relief

Where a pressure relief device is fitted and it is on the same side of the appliance as any user-operated controls, means shall be provided to prevent hazard to personnel in the event of its operation. Any shields or deflectors shall not interfere with the operation of the relief, and the installation instructions shall draw attention to the location and free area required to provide safe operation. Any such pressure relief shall be capable of withstanding the temperature of the enclosed combustion products.

4.10 Additional requirements for appliances designed for outdoor installation

4.10.1 General

Appliances designed for outdoor installation shall be constructed so that they are fully protected against the rigours of the environmental conditions under which they are expected to operate.

The flue outlet, if integral with the appliance, shall be protected against the ingress of rain or snow. Any opening in the protective guard shall not permit the entry of a ball 16 mm in diameter applied with a force of 5 N.

4.10.2 Access panels and doors

Access panels and doors and such insulation as needs to be removed during normal servicing shall be so designed that repeated removal and replacement does not damage the insulation or impair the waterproofing of the appliance.

4.10.3 Design of openings

The design of any opening, e.g. electrical wiring points, from the inside of the appliance to the outside air shall not permit the entry of foreign objects that could impair the heater operation.

4.10.4 Fixing screws

External panels intended to be removed for maintenance and servicing shall be fixed using only suitable screws, except in the case of user access panels, which may be fixed by suitable hinges and door catches.

4.11 Oil burners

Only atomising burners according to EN 267 may be used. The automatic burner control system used shall comply with EN 230 and be approved for fuel inputs > 30 kg/h to take advantage of the shorter safety times.

Where the oil burner is specially adapted to operate with the appliance then the complete appliance shall be tested in accordance with the tests defined in EN 267 except that any parts of the certified burner that are unaltered do not need to be re-examined.

4.12 Additional requirements for portable appliances

4.12.1 Stability

The appliance shall not be able to tip over if tilted to an inclination of 15°.

4.12.2 Fuel tank

If a mobile appliance is fitted with a fuel tank as part of the appliance then this shall be manufactured from metallic materials or other suitable materials following national legislation. It shall be designed so that the fuel cannot heat to more than 40 °C during the heater operation. The connection on the tank for filling shall be arranged so that on filling the tank with fuel ignition of the fuel is not possible from hot components. The filling nozzle should be easily accessible and the filling level shall be visible during filling.

5 Constructional and operating requirements

5.1 Nominal heat input

When measured under the conditions of 6.3.2.2, the heat input obtained at normal pressure shall be within ±5 % of the nominal heat input.

5.2 Limiting temperatures

5.2.1.1 The temperature of parts of the appliance which have to be touched during normal use

The surface temperatures of the control knobs and of all the parts to be touched during normal use of the appliance, measured only in the zones intended to be gripped, and under the conditions stated in 6.4 shall not exceed the ambient temperature by more than:

— 35 K for metals;

— 45 K for porcelain or similar materials;

— 60 K for plastics or similar materials.

5.2.1.2 Temperatures of the side walls, the front and the top of the appliance

The temperature of the side walls, front and top of the appliance, except for the surfaces of any flue pipe, shall not exceed the ambient temperature by more than 80 K when measured under the conditions of 6.4.2. This requirement does not apply to those parts of the case within 150 mm of the flue pipe. It also does not apply to those parts of the appliance instrumental in the transmission of heat or parts which are higher than 1,8 m above the level of the floor when the appliance is installed.

5.2.1.3 Component temperatures

When the appliance is tested under the conditions of 6.4.3 the maximum temperature of the appliance components shall not exceed the maximum temperature specified by the individual component manufacturer.

5.2.1.4 Fan motor winding temperatures

When tested under the conditions of 6.4.4 the maximum temperature rise of the motor windings shall not exceed the maximum temperature rise stated by the motor manufacturer.

5.3 Thermostats and control of air temperature

Overheat cut-off device

Under the conditions of 6.6, the following requirements shall be satisfied:

— The fuel supply to the burner shall be cut off to prevent a hazardous condition or any damage to the appliance.

— The fuel supply to the burner shall be cut off when the average temperature of the air at the appliance outlet exceeds 100 °C or, for appliances with multiple outlets and those intended to be installed with the base of the appliance more than 2,5 m from the floor level, whether or not they are fitted with multiple outlets, the average temperature at any one outlet exceeding 125 °C.

— The overheat control shall not operate during the normal cyclic action of the appliance, e.g. as a consequence of the operation of a room thermostat or other control.

— Flame stability shall be satisfactory throughout the test.

5.4 Heat exchanger thermal resistance

The manufacturer shall certify that the heat exchanger is constructed using materials of sufficient quality with regard the mechanical, chemical and thermal loads expected. The certification shall indicate that the components are constructed in a form and method that will ensure that the heaters are in safe working order for a suitable period of time, when installed, operated and maintained correctly in accordance with the manufacturer's instructions. If the manufacturer is not able to certify the above, then the test specified in 6.7 is to be carried out.

5.5 Weather resistance (only appliances designed for outdoor installation)

The manufacturer shall certify that the appliance is designed for outdoor installation and that it will operate normally and safely with specific respect to the anticipated weather conditions. Particular note should be made to the effects of water ingress, ultra-violet radiation and snow.

5.6 Efficiency

The efficiency expressed with respect to the net calorific value determined at the nominal heat input shall be greater than or equal to 84 % when measured in accordance with 6.5.6.

If the appliance has a modulating or high/low control, when measured in accordance with 6.5.8, the efficiency based on the net calorific value with the appliance adjusted to give the minimum rate shall be such that:

$$\eta_{\min} \geq \frac{84 + \eta_N}{2} - \frac{10(Q_N - Q_{\min})}{Q_N} \text{ in \%} \quad (1)$$

where

$\eta_{\min}$ is the net efficiency with the appliance adjusted to give the minimum rate;

η_N is the net efficiency determined at the nominal heat input;

Q_N is the heat input at nominal rate;

$Q_{\min}$ is the heat input at minimum rate.

5.7 Combustion requirements

5.7.1 Smoke number (see C.5)

For burners at all firing rates the smoke number shall be ≤ 1.

For multistage and modulating burners the smoke number at the minimum firing rate declared by the manufacturer may be < 2.

5.7.2 NO_x and CO

When tested under the conditions of 6.3.2.2 the emission limits for NO_x and CO modified according to Annex C shall not exceed the values given in Table 1.

Table 1 - Emission limits for NO_x and CO

Class NO	NO_x mg/kWh	CO mg/kWh
1	250	110
2	185	110
3	120	60

5.8 Combustion under normal fluctuation of auxiliary energy

The CO-concentration in the dry air-free combustion products shall not exceed 0,2 % when the appliance is supplied with reference fuel under the conditions defined in 6.8; in addition, the appliance shall ignite and continue to operate safely.

5.9 Combustion under abnormal fluctuation of auxiliary energy

If the auxiliary energy fluctuates beyond the normal variations defined in 6.8 then the appliance shall either continue to operate safely or go to safety shut-down.

6 Test methods

6.1 Conditions of supply and adjustment of the burners

6.1.1 Initial adjustment of appliance

Before all tests that are required to be carried out, the appliance shall be fitted with the appropriate equipment (nozzle(s)) corresponding to the fuel which the appliance is designed to burn using the appropriate fuel and the normal pressure(s) in accordance with the manufacturer's instruction.

6.1.2 Burner fuel pump setting pressures

Except where an adjustment of the fuel pump pressure is necessary the normal, minimum and maximum fuel pump pressures to be used for testing purposes shall be in accordance with the manufacturer’s instruction.

Unless otherwise specified, the initial adjustment of the appliance is not altered.

6.1.3 Adjustment of heat inputs

For tests requiring adjustment of the burner to the nominal or another specified heat input, it shall be ensured that the fuel pressure at the burner is such that the heat input obtained is within ±2,5 % of that specified by the manufacturer.

The specified heat input shall be calculated in accordance with 6.3 and with the appliance supplied with the appropriate fuel.

6.2 General test conditions

6.2.1 General

The following clauses are generally applicable except where otherwise specified in particular clauses.

6.2.2 Test room

The appliance is installed in a well-ventilated, draught-free room which has an ambient temperature of (20 ± 5) °C.

NOTE A wider temperature range is permissible provided that the effect on the test results can be taken into account.

6.2.3 Evacuation of the products of combustion

Appliances with a vertical flue outlet shall be tested with the minimum height of vertical flue specified by the manufacturer's installation manual. The flue shall have the same nominal diameter as the flue outlet. Appliances with a horizontal flue outlet shall be fitted in accordance with the manufacturer’s instructions; these shall include the maximum length of horizontal run and the method of adaptation to a vertical flue; thereafter the vertical flue shall be fitted as above.

The vertical flue shall be made from sheet metal. Unless otherwise stated, the flue shall be un-insulated and of a material capable of withstanding the expected temperatures of the products of combustion.

Appliances shall be tested with the minimum diameter flue as specified in the installation instructions. If the flue has been adapted for another country, the modification required shall only involve an increase in the flue diameter.

6.2.4 Test installation

The appliance shall be installed in accordance with the manufacturer's instructions.

6.2.5 Influence of thermostats

Precautions shall be taken to prevent thermostats or other controls from operating and affecting the fuel rate, unless this is necessary for the test.

6.2.6 Electrical supply

The appliance is connected to an electrical supply at the nominal voltage, except where otherwise stated in the clause concerned.

6.2.7 Range rated appliances

For appliances that are designed to be range rated, all tests are carried out at their maximum and minimum nominal heat inputs.

6.2.8 Modulating and high/low operation

For appliances with modulating or high/low operation, the tests are carried out at the nominal heat input unless otherwise stated in the particular test.

6.3 Heat inputs

6.3.1 General

For the purposes of this document all heat inputs are determined from the volumetric rate (V_0) or mass rate (M_0) which relate to the rate obtained with fuel under reference test conditions:

— for calorific values, temperature: 15 °C;

— for fuel and air volumes dry, brought to 15 °C and to an absolute pressure of 1 013,25 mbar.

The heat input (Q_o) in kW is given by one of the following expressions:

$$Q_0 = 0{,}278 \times M_0 \times H_s \quad (2)$$

$$Q_0 = 0{,}278 \times M_0 \times H_i \quad (3)$$

$$Q_0 = 0{,}278 \times V_0 \times H_s \quad (4)$$

$$Q_0 = 0{,}278 \times V_0 \times H_i \quad (5)$$

where

M_0 is the mass input in kilograms per hour (kg/h) obtained at reference conditions;

V_0 is the volume input in cubic decimetres per hour (dm^3/h) obtained at reference conditions;

H_i is the net calorific value of the reference fuel oil in megajoules per kilogram (MJ/kg) or in megajoules per cubic decimetre (MJ/dm^3), as appropriate;

H_s is the gross calorific value of the reference fuel oil in megajoules per kilogram (MJ/kg) or in megajoules per cubic decimetre (MJ/dm^3), as appropriate.

6.3.2 Fuel

6.3.2.1 General

The tests shall be carried out using commercial available fuel oil (gas oil). The viscosity of the fuel shall be at the burner inlet of 1,6 mm²/s (cSt) up to 6 mm²/s (cSt) at 20 °C.

Alternatively for kerosene the viscosity shall be 1,3 mm^2/s (cSt) to 2,9 mm^2/s (cSt) at 20 °C.

6.3.2.2 Nominal heat input

The appliance is fitted successively with each of the prescribed nozzles and adjusted in accordance with 6.1.2.

The measurements are taken with the appliance at thermal equilibrium and with any thermostat put out of action.

The heat input obtained Q_o is compared with the nominal heat input Q_N in order to verify the requirement of 5.1

The heat input is determined for each fuel specified by the manufacturer.

It is recommended that the fuel throughput is measured by weight over a given time however the volume of the fuel may be measured as an alternative.

6.3.2.3 Calorific value of heating fuel oil (gas oil)

If the calorific value is not determined calorimetrically and in the absence of a complete analysis, the value for fuel oil can, with sufficient accuracy, be assumed as follows:

H_i = 42,689 MJ/kg

H_s = 45,5 MJ/kg

where

Carbon content c = 0,86 kg/kg;

Hydrogen content h = 0,136 kg/kg;

Sulphur content s = 0,003 kg/kg;

density at 15 °C: 0,85 kg/dm^3.

If the density and sulphur content is known (e.g. by analysis) the calorific value can be calculated as follows:

$$H_i = 52{,}92 - (11{,}93 \times \rho_{15}) - (0{,}3 \times s) \text{ in MJ/kg} \quad (6)$$

where

ρ_{15} = density of the fuel at 15 °C in kg/dm^3;

s = Sulphur content in kg/kg.

6.3.2.4 Calorific value of kerosene fuel oil

If the calorific value is not determined calorimetrically and in the absence of a complete analysis, the value for kerosene can with sufficient accuracy be assumed as follows:

H_i = 43,300 MJ/kg

H_s = 45,5 MJ/kg

where

Carbon content c = 0,85 kg/kg;

Hydrogen content = 0,141 kg/kg;

Sulphur content s = 0,004 kg/kg;

density at 15 °C: 0,79 kg/dm^3.

If the density and sulphur content is known the calorific value can be calculated as in the formula in 6.3.2.3.

6.4 Temperature of parts of the appliance which have to be touched during normal use

6.4.1 General

The temperatures of the parts specified in 5.2 shall be measured at thermal equilibrium using an instrument with an accuracy of ±2 K, for example using contact thermocouples, and compliance with the requirements of 5.2 is verified.

6.4.2 Temperatures of the side walls, front and top of the appliance

The test is carried out when the appliance has reached thermal equilibrium.

The temperatures of the hottest parts of the side walls, front and top of the appliance are measured by a suitable means having an accuracy of ±2 K, for example using contact thermocouples, and compliance with the requirements of 5.2.1.2 is verified.

6.4.3 Component temperatures

Component temperatures are measured when thermal equilibrium has been reached and after the appliance has been turned off at the end of the test, and compliance with the requirements of 5.2.1.3 is verified.

The component temperatures are measured by means of attached thermocouples having thermoelectric junctions with an accuracy of ±2 K. Alternative devices of equivalent accuracy may by used.

However, if an electrical component is itself likely to cause a rise in temperature (e.g. automatic shut-off valves) the temperature of the component is not measured. In this case, thermocouples or alternative devices, are placed so as to measure the air temperature around the device.

The temperature measurements of the components are deemed to be satisfactory if:

$$t_m \leq \left(t_s + t_a - 25^0 C\right) \tag{7}$$

where

t_m is the maximum temperature measured in the test in degrees Celsius (°C);

t_s is the maximum temperature specified by the component manufacturer in degrees Celsius (°C);

t_a is the ambient room temperature in degrees Celsius (°C).

NOTE If the maximum temperature of the component was specified for an ambient temperature other than 25 °C, this should be used.

6.4.4 Fan motor winding temperatures

The appliance is installed according to the conditions of 6.2 and supplied with electricity by means of a device that enables the voltage to be varied from 85 % of the minimum to 110 % of the maximum of the voltage range declared by the manufacturer, e.g. a variable voltage transformer.

The test is carried out in still air and with the appliance adjusted to its nominal heat input, using an appropriate reference fuel. The voltage is adjusted to the most unfavourable value between the above limits.

Temperature measurements are made when the appliance has reached thermal equilibrium and after the appliance has been switched off by the normal means of control, and compliance with the requirements of 5.2.1.4 is verified.

The resistance of the windings is measured as soon as possible after switching off and then at short intervals so that a curve of the resistance against time from switch-off can be plotted, in order to determine the maximum resistance value.

The temperature rise of the windings is calculated from the formula:

$$\Delta t = \frac{R_1 - R_2}{R_1} \times (C + t_1) - (t - t_1) \qquad (8)$$

where

Δt is the temperature rise in Kelvin (K);

R_1 is the resistance at the beginning of the test in ohms (Ω);

R_2 is the maximum resistance at the end of the test in ohms (Ω);

t_1 is the room temperature at the beginning of the test in °C;

t_2 is the room temperature at the end of the test in °C;

C is a constant equal to 234,5 °C for copper.

6.5 Efficiency

6.5.1 Principle of method

The thermal efficiency is determined by the flue loss method from measurements of CO_2 or O_2 concentration and the temperature of the products of combustion.

Where the appliance is intended for use within the heating space then the surface loss of the case may be ignored.

6.5.2 Preparation of appliance

The appliance is installed in accordance with 6.2 and operated, in accordance with the manufacturer's instructions, with the appropriate fuel oil.

6.5.3 Test conditions

The appliance is supplied with the reference fuel and operated within ±2,5 % of the specified heat input(s) using the minimum delivered air flow declared by the manufacturer.

The CO_2 or O_2 concentration and the temperature of the combustion products are measured by means of a suitable probe, incorporating a temperature-measuring device, located in the flue system. The sampling rate of combustion products for the measurement of temperature is approximately 100 l/h.

The test probe is positioned 2 D above the flue outlet connection on the appliance (see Figure 3).

6.5.4 Test procedure

With the appliance installed and adjusted as described in 6.1.3, the appliance is operated for a sufficient time to reach thermal equilibrium. Measurements are then made of the temperature, the CO concentration and the CO_2 concentration of the combustion products and of the combustion air.

The fuel rate is measured by weighting the fuel used over a period of at least 600 s.

6.5.5 Accuracy of measurement

Measurements are made to the following accuracy.

Table 2 — Accuracy of measurement

Quantity measured	Measurement accuracy
Combustion air temperature	±0,5 °C
Combustion products temperature	±2 °C
CO_2 concentration of the combustion air and the combustion products	±6 % of the sample concentration
CO concentration of the combustion air and the combustion products	±6 % of the sample concentration
NO_x concentration of the combustion air and the combustion products	±6 % of the sample concentration

6.5.6 Calculation of efficiency

The following formula applies if the air and fuel are introduced to the combustion equipment at ambient temperature, not preheated;

$$\eta = 1 - q_A - q_S \tag{9}$$

$$q_{\mathrm{A}} = \frac{V_{\mathrm{A}} \times C_{\mathrm{pm,\,Atr}}}{H_i} \times (t_{\mathrm{A}} - t_{\mathrm{L}}) \tag{10}$$

where

η is the efficiency relative to the net heat input

q_{A} is the sensible heat loss in flue gases (relative to the net heat input);

V_{A} is the volume of products of combustion in m^3/kg of the fuel burned;

t_{A} is the temperature of the products of combustion, in °C;

t_{L} is the temperature of the ambient air, in °C;

$C_{\mathrm{pm,\,Atr}}$ is the mean specific heat of the products of combustion in the range of t_{L} to t_{A}, J/(m^3 · K);

H_{i} net calorific value of the fuel, J/kg;

q_{S} is the surface loss (relative to the net heat input).

The volume of flue gases V_A can generally be established as follows if the combustion with the excess of air is imperfect:

a) Dry flue gases/

$$V_{Atr} = V_{CO_2} + V_{SO_2} + V_{N_2} + V_{O_2} = \frac{V(CO_2 + SO_2)}{(CO_2 + SO_2)_{measured}} \quad \text{in } m^3/kg \tag{11}$$

$$V_{Atr} = V_{Atr,\,min} \times \frac{100}{100 - 4{,}76 \times O_2} \tag{12}$$

where

V_{CO_2} is the volume of carbon dioxide CO_2 in m^3/kg;

V_{SO_2} is the volume of sulphur dioxide SO_2 in m^3/kg;

V_{N_2} is the volume of nitrogen N_2 in m^3/kg;

$(CO_2 + SO_2)_{measured}$ is the measured proportion of $(CO_2 + SO_2)$ in the flue gases in m^3/kg;

O_2 is the measured proportion of O_2 in the flue gases in m^3/kg;

$V_{Atr,\,min}$ is determined from equation (A.3), see EN 304:1992, Annex A.

b) the volume of water vapour V_W resulting from water content and the combustion of the water forming components of the fuel in m^3/kg or m^3/m^3 (the water content of the combustion air may be ignored).

When the volume of water vapour is separated from the volume of dry products of combustion, the equation becomes:

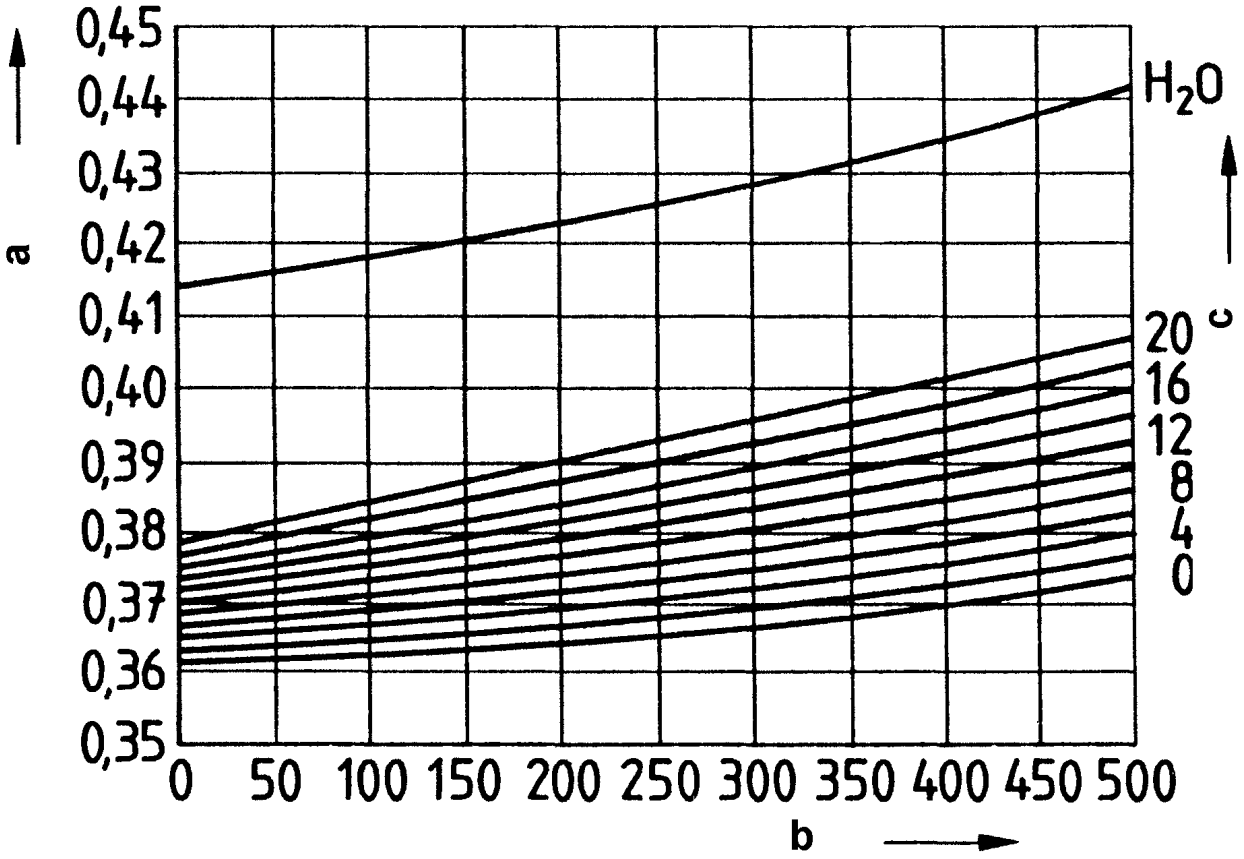
$$q_A = (V_{Atr} \times C_{pm,\,Atr} + V_W \times C_{pm,\,H_2O}) \times (t_A - t_L) \times \frac{1}{H_i} \tag{13}$$

where

$C_{pm,\,Atr}$ is the mean specific heat of the dry flue gas in the temperature range t_L to t_A, in $J/(m^3 \cdot K)$;

$C_{pm,\,H_2O}$ is the mean specific heat of the water vapour in the temperature range t_L to t_A, in $J/(m^3 \cdot K)$.

The values for the mean specific heat of the dry flue gases related to the CO_2 content and water vapour can be taken from Figure 1.



Key

a $C_{pm,\,Atr}$, $C_{pm,\,H_2O}$ in Wh/(m^3 · K)

b t_A flue gas temperature in °C

c CO_2-content in %

Figure 1 — Mean specific heat capacities for dry combustion products and water vapour at flue gas temperatures up to and including 500 °C

Equation for determination (valid up to t_A = 500 °C)

$$C_{pm,\,Atr} = 0{,}361 + 0{,}008 \times \left[\frac{t_A}{1000\ °C}\right] + 0{,}034 \times \left[\frac{t_A}{1000\ °C}\right]^2 + \left[\left[0{,}085 + 0{,}19 \times \left[\frac{t_A}{1000\ °C}\right] - 0{,}14 \times \left[\frac{t_A}{1000\ °C}\right]^2\right]\right] \times \left[\frac{CO_2}{100\ \%}\right] + \left[\left[0{,}3 \times \left[\frac{t_A}{1000\ °C}\right] - 0{,}2 \times \left[\frac{t_A}{1000\ °C}\right]^2\right]\right] \times \left[\frac{CO_2}{100\ \%}\right]^2 \quad (14)$$

$$C_{pm,\,H_2O} = 0{,}414 + 0{,}038 \times \left[\frac{t_A}{1000\ °C}\right] + 0{,}034 \times \left[\frac{t_A}{1000\ °C}\right]^2 \quad (15)$$

where

$C_{pm,\,Atr}$ is the mean specific heat capacity for dry combustion t_A, in Wh/(m^3 · K);

$C_{pm,\,H_2O}$ is the mean specific heat capacity for water vapour, in Wh/(m^3 · K).

6.5.7 Surface heat loss

Only required for appliances designed for installation outside of the heated space.

The outer surface of the appliance is divided up into areas of similar temperature and their temperatures measured by a suitable method e.g. surface thermocouples. The heat emission from the surface section is calculated as follows:

$$Q_X = F_X \times \alpha \times (t_m - t_L) \quad (16)$$

where

Q_x heat emission from surface section, in W;

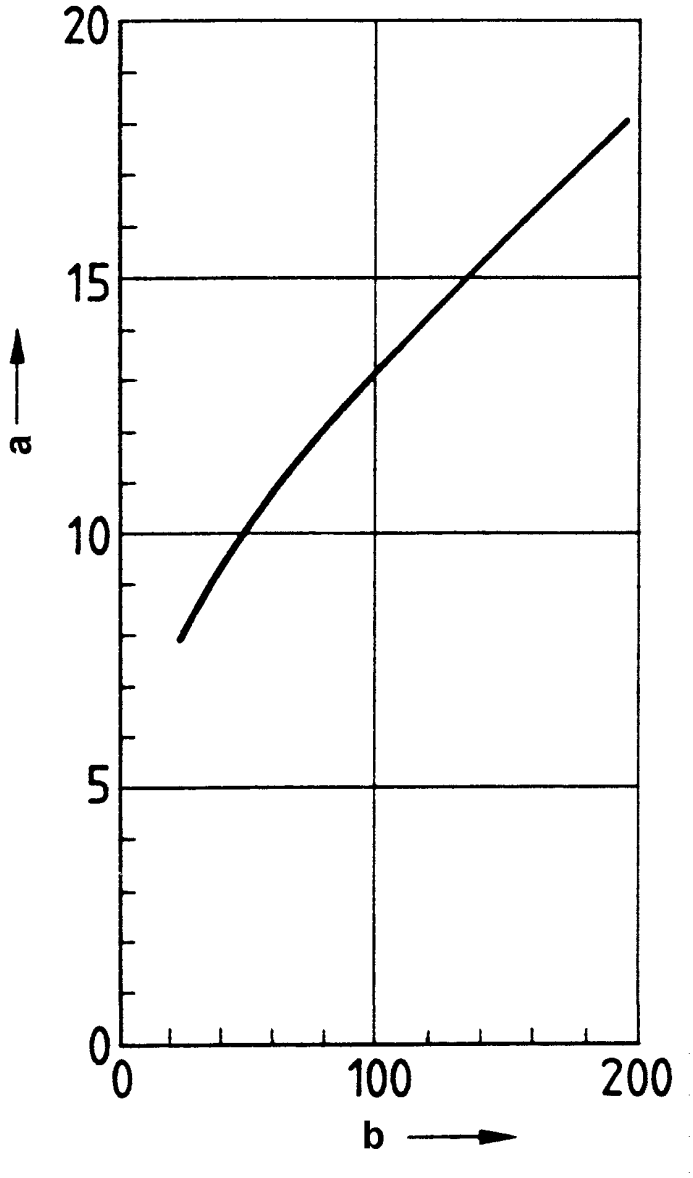
F_x surface area of the section, in m^2;

α heat transfer coefficient, in W/(m^2 · K);

t_m mean surface temperature of the section, in °C;

t_L room temperature (measured at a point 1,5 m from the front of the appliance at a height equal to half the appliance `s height), in °C.

Approximate heat transfer coefficients relative to the temperature of the surfaces can be obtained from Figure 2.



Key

a α in Wh/(m² · K)

b t_m in °C

Figure 2 — Total heat transmission figure α by radiation and free convection to the horizontal and vertical surfaces at an ambient temperature t_L = 20 °C as a function of the mean surface temperature t_m

The loss q_S can be obtained from:

$$q_S = \frac{\sum Q_X}{Q_B} \tag{17}$$

where

Q_B is the net heat input measured during the test, in W.

6.5.8 Supplementary test for appliances with a modulating or high/low control

The test is carried out and the efficiency measured as specified in 6.5, with the appliance adjusted to give the minimum rate.

It is checked that the requirement of 5.6 is met.

6.6 Overheat cut-off device

6.6.1 General

When tested in accordance with 6.6.2 to 6.6.3 the requirements of 5.3 shall be met.

6.6.2 Test no. 1

6.6.2.1 General

The appliance is installed as described in 6.1 and supplied with a suitable reference fuel at the manufacturer's maximum nominal heat input. Any air temperature control or air flow control devices are rendered inoperative.

Dependent on the appliance design and test suitability, then carry out the test as described in 6.6.2.2, 6.6.2.3 or 6.6.2.4.

6.6.2.2 Appliances designed to be connected to air distribution ductwork or appliances where the air flow static pressure is designed to be ≥ 100 Pa

Any air outlet louvers are set to give zero deflection of the delivered air. A duct of 1,0 m in length having the same cross section and dimensions as the appliance outlet shall be connected to each outlet (for the purposes of this test the manufacturer shall supply the necessary duct).

The open end of the duct is fitted with a device that will symmetrically reduce the cross sectional area of the duct outlet.

At the centre of the open end of the duct a single thermocouple or similar device is placed to measure the temperature of the air leaving the appliance.

The appliance is operated and the air flow is gradually reduced, using the restrictor device, until the overheat cut-off device operates to turn off the burner and the air temperature is noted.

The overheat cut-off device is reset as soon as it is possible to do so and the test is repeated.

If the temperature recorded is higher than the first recorded temperature then the test is repeated until the worst condition is reached.

6.6.2.3 Appliances with a single outlet to the space

Any air outlet louvers are set to give zero deflection of the delivered air. A duct of 1,0 m in length having the same cross section and dimensions as the appliance outlet shall be connected to the outlet (for the purposes of this test the manufacturer shall supply the necessary duct).

Sufficient thermocouples, or similar devices are placed at 0,5 m from the appliance outlet and parallel to the plane of that outlet within the duct and positioned to give the average temperature of the delivered air. Five thermocouples in the shape of a cross will normally be suitable.

The appliance is operated and the air flow is gradually reduced, by reducing the voltage supply to the fan or other suitable means, until the overheat cut-off device operates to turn off the burner and the average air temperature is noted.

The overheat cut-off device is reset as soon as it is possible to do so and the test is repeated.

If the temperature recorded is higher than the first recorded temperature then the test is repeated until the worst condition is reached.

6.6.2.4 Appliances designed to be free blowing into the heated space and fitted with multiple outlets

Any air outlet louvers are set to give zero deflection of the delivered air.

Sufficient thermocouples, or similar devices, are placed to measure the average air temperature at each outlet and in the plane of that outlet. Five thermocouples in the shape of a cross will normally be suitable.

The appliance is operated and the air flow is gradually reduced by progressively closing off the air inlet to the fan in a symmetrical manner, or other suitable means, until the overheat cut-off device operates to turn off the burner and the average air temperature is noted.

The overheat cut-off device is reset as soon as it is possible to do so and the test is repeated.

If the temperature recorded is higher than the first recorded temperature then the test is repeated until the worst condition is reached.

6.6.3 Test no. 2

The appliance is installed in accordance with 6.1.

The air temperature control and the air distribution fan are rendered inoperative.

The appliance is operated from the cold condition at the nominal heat input using an appropriate reference fuel. However, range-rated appliances are operated at the maximum heat input specified by the manufacturer.

The appliance is operated until the overheat control operates to cut off the fuel to the main burner. The appliance is cycled on the overheat control for sufficient time to ensure that the worst condition has been reached.

The manual reset mechanism is operated after the first cut-out and after each minute of this and every subsequent cooling period until the control permits reheat.

No hazardous conditions or any damage to the appliance may occur.

6.7 Heat exchanger thermal resistance

NOTE 1 This test is to be carried out, if the manufacturer cannot certify the requirement of 4.1 and 4.3.

Prior to the test being carried out, the heat exchanger is carefully examined and any manufacturing abnormalities noted (e.g. tool damage, welding faults, careless assembly, etc.). Any such abnormalities are not considered in the final examination of the heat exchanger.

The appliance is installed under the conditions of 6.1 and operated at the normal pressure using an appropriate reference fuel.

A thermocouple wired to an independent control is attached to the body of the overheat cut-off device. The air temperature control device is disconnected and the appliance is operated until the overheat cut-off device operates to cut off the fuel to the main burner. The temperature sensed by the thermocouple at the moment of shut-off is recorded by the independent control.

The overheat cut-off device is then disconnected and replaced by the independent control set to shut the appliance down at a temperature of 10 K above the temperature of the thermocouple previously recorded.

NOTE 2 If an appliance is fitted with a reset table temperature limiter (overheat control device) in addition to the overheat cut-off device, the former may be used as the basis for conducting the test, i.e. fixed at a temperature of 10 K above its set point.

The appliance is then operated with the fuel on and the air distribution fan off until the independent control shuts the appliance down. The air distribution fan is then switched on and runs for 3,5 min.

The cycle is repeated 5 000 times.

If components other than the heat exchanger are adversely affected during the thermal cycling test, action shall be taken to safeguard such components. Heat exchanger and burning chamber shall not have deleterious effects after this test.

NOTE 3 If it can be shown the either the physical form of the heat exchanger, or the type of control adopted, make such a test inappropriate. An equivalent test may be devised between the manufacturer and the notified body.

6.8 Combustion under normal fluctuations of auxiliary energy

Without altering the initial burner adjustment the appliance is supplied with the appropriate reference fuel and operated at nominal heat input.

The test is carried out with the electrical supply to the appliance (or burner only) adjusted to 85 % of the minimum voltage and then at 110 % of the maximum voltage range as stated by the manufacturer.

It is checked that the requirements of 5.4 are met.

7 Marking and instructions

7.1 Marking of the appliance

7.1.1 Description

Appliances are described by their:

— manufacturer and type name;

— nominal input, or range of adjustable inputs.

7.1.2 Data plate

The appliance shall carry one or more data plates and/or labels that are firmly and durably attached to the appliance such that the information given is visible to, and can be read by, the installer. The data plate(s) and/or label(s) shall give at least the following information where applicable:

— the manufacturer's name[1]), or authorised representative, and address;

— the nominal heat input and, where necessary, the range of input for an appliance with an adjustable input, expressed in kilowatts, stating whether it is based on net or gross calorific value;

— the trade name of the appliance;

— the serial number;

— the commercial identification of the appliance;

[1]) Manufacturer means the person, organisation or company who assumes responsibility for designing and manufacturing a product with a view to placing it on the market on their own behalf within the EU.

— the type of fuel, for which the appliance has been adjusted;

— the nature and voltage of the current used and the maximum electrical input power used (volts, hertz and kilowatts) for all intended electrical supply conditions.

7.1.3 Other marking

The appliance shall be marked with the following text:

“This appliance shall be installed in accordance with the rules in force, and used only in a sufficiently ventilated space. Consult instructions before installation and use of this appliance.”

7.1.4 Electrical supply

The marking concerning electrical values shall be in conformity with EN 60335-1.

7.2 Marking of the packaging

The packaging shall carry at least the following information:

“This appliance shall be installed in accordance with the rules in force, and used only in a sufficiently ventilated space. Consult instructions before installation and use of this appliance.”

7.3 Instructions

7.3.1 General

Instructions have at least to fulfil the relevant standards as required.

NOTE See also directive 98/37/EG.

7.3.2 Technical instructions for installation and adjustment

In addition to the information given in 7.3.1, the technical instructions shall explain the installation conditions for the appliance (on a floor or wall etc.) and its accessories (room thermostat etc.); they shall state the minimum distance necessary between the appliance surfaces and any nearby walls, and also any precautions to be taken to avoid overheating the floor, walls or ceiling if these are made from combustible materials.

The instructions shall also state the minimum and maximum ambient temperature in which the appliance is designed to operate.

They shall provide information on the combustion and ventilation air requirements, the fuel and electricity supply and connections and procedure to be followed for commissioning the appliance.

In addition, the installation instructions shall include a complete wiring diagram and a technical data table. The technical data table shall include the appliance heat input, heat output, rating of burner, burner pressure, nozzle sizes, number of nozzles (where necessary), fuel connection size, flue size, physical dimensions, mass, electric motor details, fan ratings, air delivery volumes, and such other technical data as may be required by the installer and commissioning engineer.

The instructions shall state the minimum and maximum equivalent resistance, or such other information for the assembly of the flue system, and give details for calculating the equivalent resistance, for example the allowance to be made for bends etc.

The installation instructions shall specify the method of adjusting any damper or other combustion air controlling device.

They shall also give all relevant information for adjusting the fuel and delivered air rates.

If the manufacturer claims that the appliance is suitable for use in garages, then the instruction for installation shall take into account the relevant national installation rules.

If the appliance is intended for outdoor use, this shall be made clear in the instructions.

7.3.3 Instructions for use and maintenance

All the instructions shall be provided by the manufacturer. The instructions for use and maintenance shall provide all the necessary information for the safe and sensible use of the appliance.

In particular, they shall deal with the operations of ignition and extinction (see also 7.4.5), the use of the various controls with which the appliance may be fitted, simple cleaning and maintenance of the appliance, also mentioning, where necessary, the nature of the products recommended. They shall also stress that a qualified installer is required to install, adjust and, where necessary, convert the appliance for use with other fuel types.

They shall also state the recommended frequency of periodic servicing.

7.3.4 Instructions for servicing

The servicing instructions shall indicate the frequency of servicing and the scope of the service programme recommended by the manufacturer. They shall also specify such special tools as are necessary for any servicing procedure.

The procedure for removing or gaining access to parts or components to be serviced, together with the recommended service work and associated procedures, shall be clearly defined.

The instructions shall also include complete electrical, functional and wiring diagrams and a short list of appliance parts and part numbers of those items that the manufacturer considers may be required for replacement purposes during the life of the appliance.

Reference shall also be made to the necessity for consulting the appliance manufacturer before replacing parts other than those specified or recommended in the servicing instructions.

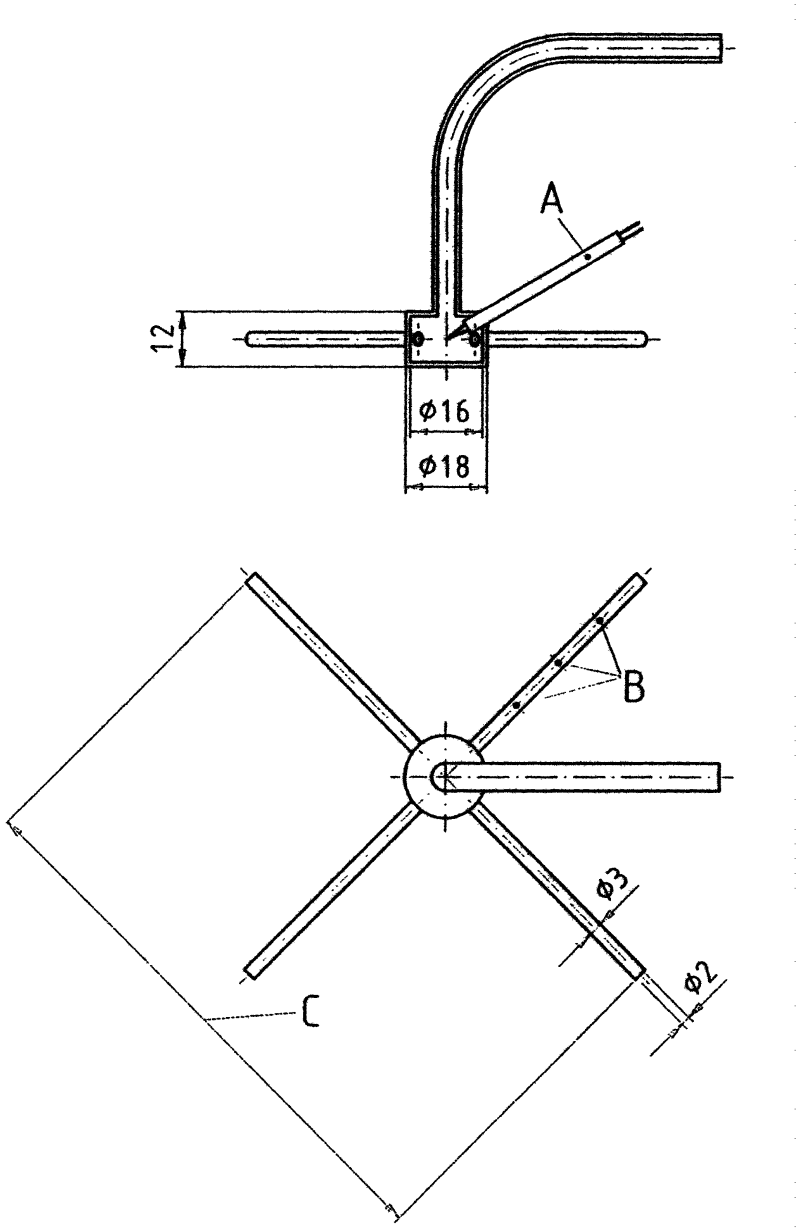
A fault finding chart shall be incorporated as an aid to servicing. The service instructions shall also include a line or block diagram showing the arrangement of the fuel controls.

The servicing instructions shall contain any specific recommendations for emergency servicing under wet conditions, including the provision of weatherproof covers, for appliances designed for outdoor installation.

The servicing instructions shall draw attention to the necessity for re-commissioning the appliance after servicing.

They shall deal with the assembly of parts which are likely to be replaced, and the electric motor and the fan, and with cleaning.

Dimensions in millimetres



Key

A Steatite tube with two holes into which thermocouple wires are sealed

B Three holes (∅ 1 mm) per limb, equally spaced along the limb

C 0,97 D, where D is the internal diameter of the flue

NOTE The material is stainless steel with a polished finish.

Figure 3 — Sampling probe for products of combustion in the flue

Annex A
(informative)

Flue connections

A.1 Flue connections in various countries

Table A.1 shows the diameters of flue pipes marked in the various countries.

Table A.1 — Diameters of flue pipes marketed in the various countries

AT	60, 70, 80, 90, 100, 110, 120, 130, 150, 180, 200
BE	60, 70, 80, 90, 100, 110, 120, 130, 150, 200, 250, 300
CH	
DE (int)	60, 70, 80, 90, 100, 110, 120, 130, 150, 180, 200, 250, 300, 350
DK	80, 90, 100, 110, 125,135, 150, 155, 160, 175, 180, 200, 250, 300, 315
ES	
FI	
FR (ext.)	66, 83, 97, 111, 125, 139, 153, 167, 180
GB (int.) [a]	75, 101, 126, 152 (metal pipes)
GR	
IE (int.) [a]	75, 101, 126, 152 (metal pipes)
IT (int)	60, 80, 100, 110, 120, 150
NL	50,60, 70, 80, 90, 100, 110,130, 150, 180, 200
NO	
PT	
SE	

[a] Larger flue pipes are also marketed.

Annex B
(normative)

Classification according to the evacuation of the combustion products

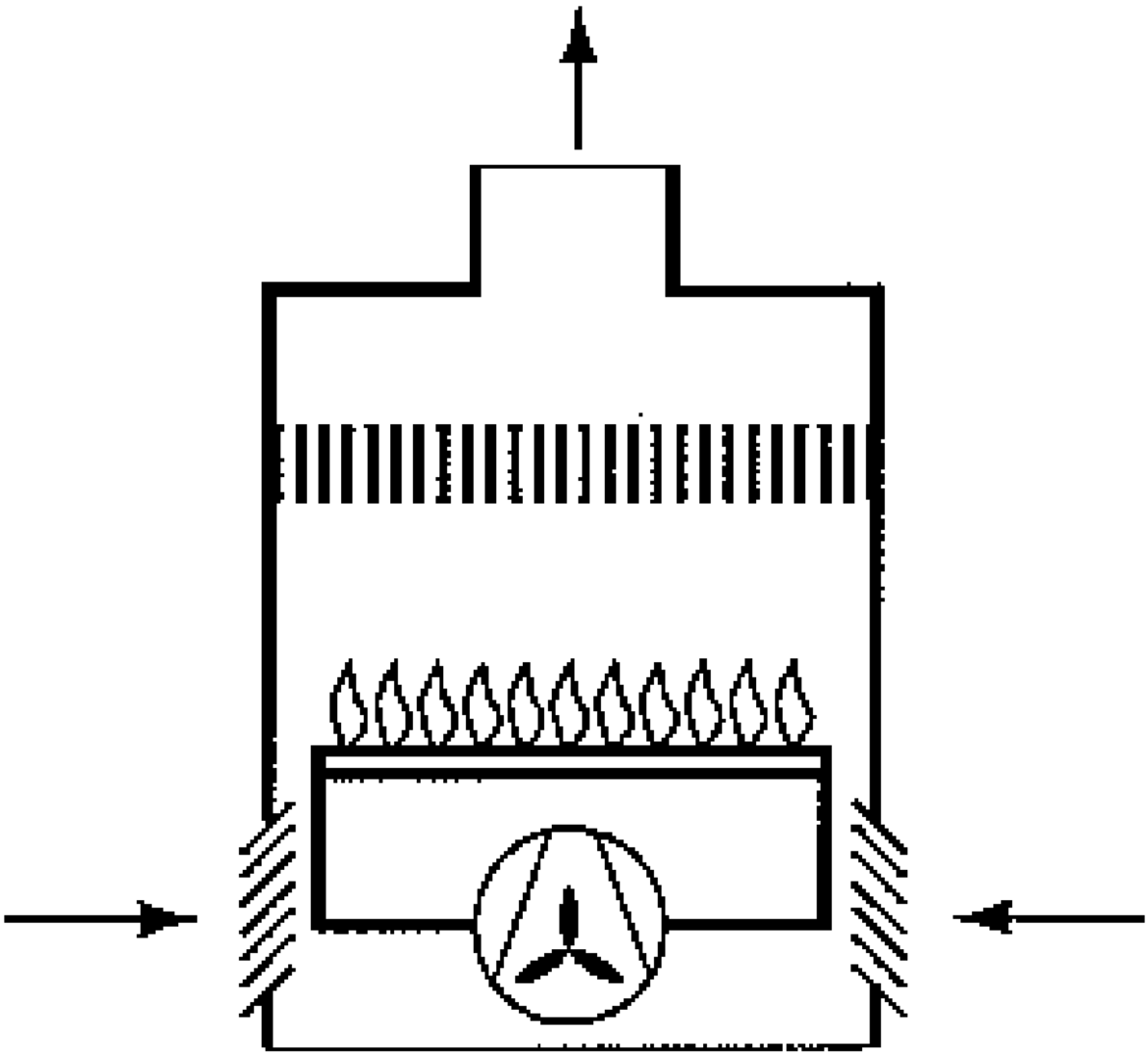


Figure B.1 — Flue Type B_{23}

Annex C
(normative)

Measurements

C.1 Pressure measurements

For measured values up to 0,6 mbar, the admissible error is 0,01 mbar, for higher values it is equal to 2 % of the measured value.

C.2 Volume measurement (fuel)

The instruments for measuring volume flow shall be checked before the tests by weighing the mass flowing. The error in the appropriate measuring range shall not exceed 0,5 % of the volume flowing.

A stop watch calibrated in 0,01 min shall be used for the time element in flow measurement.

C.3 Fuel quantity measurement

Volumetric measurement shall give an accuracy of ±0,5 % of the flow measured by the measuring vessel.

C.4 Calculation of combustion parameters

The values of the components to be used and the following equations appear in Table C.1. An example is given in [ ]:

Oxygen requirement:

$$O_{\min} = \sum 3 \quad \text{in m}^3/\text{kg} \tag{C.1}$$

Air requirement:

$$L_{\min} = \frac{O_{\min}}{0{,}21} \quad \text{in m}^3/\text{kg} \tag{C.2}$$

Dry flue gas volume for stoichiometric combustion:

$$V_{\text{Atr, min}} = \sum 5 + \sum 7 + \sum 11 + O_{\min} \times \frac{0{,}79}{0{,}21} \quad \text{in m}^3/\text{kg} \tag{C.3}$$

Maximum carbon dioxide content:

$$CO_{2\max} = \frac{\sum 7}{V_{\text{Atr, min}}} \quad \text{in m}^3/\text{kg} \tag{C.4}$$

Maximum sulphur content:

$$SO_{2\max} = \frac{\sum 7}{V_{\text{Atr, min}}} \quad \text{in m}^3/\text{kg} \tag{C.5}$$

Actual dry flue gas volume:

$$V_{\mathrm{Atr}} = \frac{V_{\mathrm{CO_2}} + V_{\mathrm{SO_2}}}{(CO_2 + SO_2)_{\mathrm{measured}} + CO_{\mathrm{measured}}} = \frac{\sum 5 + \sum 7}{(CO_2 + SO_2)_{\mathrm{measured}} + CO_{\mathrm{measured}}} \quad \text{in m}^3/\text{kg} \qquad \text{(C.6)}$$

Water vapour content:

$$V_{\mathrm{w}} = \sum 9 \quad \text{in m}^3/\text{kg} \qquad \text{(C.7)}$$

Using V_{Atr} and V_{w} the flue gas loss q_{A} is calculated from the equation (14) or (15) in clause 6.

The following combustion parameters result from C.4:

Oxygen requirement:

$$O_{\min} = \sum 3 = \left[2{,}346\ \mathrm{m^3/kg}\right]$$

Air requirement:

$$L_{\min} = \frac{O_{\min}}{0{,}21} = \left[11{,}17\ \mathrm{m^3/kg}\right]$$

Dry flue gas volume for stoichiometric combustion:

$$V_{\mathrm{Atr,min}} = \sum 5 + \sum 7 + \sum 11 + O_{\min} \times \frac{0{,}79}{0{,}21}$$

$$= [1{,}60] + [0{,}0016] + [0] + [2{,}346] \times \frac{0{,}79}{0{,}21} = \left[10{,}427\ \mathrm{m^3/kg}\right]$$

Table C.1

	1	2	3	4	5	6	7	8	9	10	11
Constituents in fuel	**Material content kg/kg**	**O_2 requirement in m³/kg of fuel**		**Flue gas constituents resulting from fuel in kg/kg of fuel**							
				CO_2		**SO_2**		**H_2O**		**N_2**	
a			**Material x O_2 requirement**		**Material x CO_2 content**		**Material x SO_2 content**		**Material x H_2O content**		**Material x N_2 content**
c	[0,865]	1,86	[1,608 9]	1,85	[1,6003]						
s	[0,002 4]	0,7	[0,001 7]			0,68	[0,001 6]				
h	[0,132 5]	5,55	[0,735 4]					11,1	[1,470 8]		
n	[0,000 1]	—								0,8	[0,000 1]
o	[0]	–0,7	[0]								
w (water)	[0]							1,24	[0]		
Σ (total)	[1,0]	$O_{\min}$ =	[2,346]	V_{CO_2} =	[1,6]	V_{SO_2} =	[0,001 6]	V_W =	[1,470 8]	V_{N_2} =	[0]

a In accordance with fuel analysis, calculation in [ ].

Maximum carbon dioxide content:

$$CO_{2\,\max} = \frac{\sum 5}{V_{\mathrm{Atr,\,min}}} = \frac{[1{,}600]}{10{,}427} = [0{,}153\,4] = [15{,}34\ \%] \text{ by volume}$$

Maximum sulphur content:

$$SO_{2\,\max} = \frac{\sum 7}{V_{\mathrm{Atr,\,min}}} = \frac{[0{,}001\,6]}{10{,}427} = [0{,}000\,1534] = [0{,}015\,3\ \%] \text{ by volume}$$

Quantity of water vapour:

$$V_{\mathrm{w}} = \sum 9\,[1{,}471\,\mathrm{m^3/kg}]$$

True quantity of dry flue gases:

$$V_{\mathrm{Atr}} = \frac{V_{\mathrm{CO_2}} + V_{\mathrm{SO_2}}}{(CO_2 + SO_2)_{\mathrm{measured}} + CO_{\mathrm{measured}}} = \frac{\sum 5 + \sum 7}{(CO_2 + SO_2)_{\mathrm{measured}} + CO_{\mathrm{measured}}}$$

Assuming that the measured $(CO_2 + SO_2) = [14{,}2]\,\%$ by volume and the measured $CO = [1{,}02]\,\%$ by volume the example shows:

$$V_{\mathrm{Atr}} = \frac{[1{,}6] + [0{,}001\,6]}{[0{,}142] + [0{,}000\,2]} = \frac{[1{,}601\,6]}{[0{,}142\,2]} = [11{,}26]\,\mathrm{m^3/kg}$$

C.5 Smoke number

C.5.1 Apparatus

C.5.1.1 Pump (hand)

Capable of drawing a volume of 160 $\mathrm{cm^3} \pm 5$ % through an effective filtering surface of 6 mm diameter in a single action of the pump. (i.e. approximately 570 $\mathrm{cm^3} \pm 5$ % per square centimetre of effective filtering surface); the piston stroke of the pump shall be approximately 200 mm.

The tightening of the paper fixing device, carried out with the paper placed in the recess provided, shall give sufficient water – tightness to prevent the formation of condensate and heating during the first operation of the pump.

The distance travelled by the gases from the sampling point to the filtering surface shall not exceed 40 cm subject to exceptional conditions of the smoke duct, to be indicated on the test report.

C.5.1.2 Sampling tube

With an internal diameter of 6 mm, and fulfilling the requirements of C.5.1.1.

C.5.1.3 Filter paper

With a reflection factor of $(85 \pm 2{,}5)$ % determined photometrically. For this filter paper shall be placed on a white surface of reflection factor 75 % or over.

The passage of air through the filter paper, at a rate of 3 dm^3/cm^2 per minute shall give a pressure drop of between 2 kPa and 10 kPa (20 mbar and 100 mbar).

C.5.1.4 Smoke number comparison scale

Comprising ten printed grade scales spaced at regular intervals from white to dark grey, realised in a white material with a reflection factor of (85 ± 2,5) %. The reflection of the first sample corresponds to that of the background paper and refers to smoke number 0. The identification number of each of the following grades is equal to a tenth of the reduction rate, expressed in a percentage of the reflection of incident light on the corresponding sample. Number 6, for example, corresponds to a reduction rate of 60 %. The tolerance for the deviations in reflection factor for each of the points of the scale shall not exceed 3 % of its value.

It is admissible to protect the scale by a transparent covering. The test mark and standard grade shall then be observed through the same thickness of protective material.

The printed grades of the reference scale shall have a diameter of approximately 20 mm, each of them being provided with a central circular window of diameter approximately 6 mm.

C.5.1.5 Electronic sampling

The test method described in C.5.1.1 to C.5.1.4 can be applied by means of an electronic sample device, provided that the test index, which is being compared by the person performing the test with the comparison scale, or which is shown as a value by the appliance, corresponds to the method described in C.5.1.

C.5.2 Determination of the smoke number

Loosen the paper fixing device, insert the filter paper in the slot provided in the pump and tighten the device.

Place the sampling probe perpendicularly to the flow direction of the combustion gases. Leak tightness shall be assured between the probe and the wall of the pipe in which the sample is taken. Samples may be taken either with a hand pump, or with the aid of an electromechanical pump.

If a hand pump according to C.5.1.1 is used, carry out ten suction actions; each action shall be regular and last between 2 s and 3 s.

Withdraw the tube from the gas duct, unscrew the fixing device, and carefully take out the filter paper.

Make a visual comparison of the test mark with the standard grades by applying the strip of filter paper against the back of the reference range. Examine the mark through the central window of the standard grades. The smoke number is indicated by the number of the sample, the shade of which is closest to that of the test mark.

If an electronic smoke device is used, the measuring head is to be placed on the blackening mark in a way so that only the reflections of the blackening mark and no other parts of the filter paper are taken.

C.6 FID measuring method for recording the unburned hydrocarbons

C.6.1 Measuring system

The measurement is effected by a flame ionisation detector (F.I.D.). The carbon in the hydrocarbon substances is ionised, i.e. charged electrically.

The thermic dissociation takes place in the flame of the burner, both at the surface and in the nucleus.

For this process the temperature of the flame and the construction of the burner is of importance.

The hydrocarbons of low quality are burned on the surface and the hydrocarbons of high molecular weight are burned in the nucleus. Transverse sensitivity to oxygen shall be excluded.

C.6.2 Starting

The lines between the calibration gases and the appliance shall first be cleaned with a solvent, for example Dichloromethane CH_2Cl_2, and then be degassed with cleaned neutral gas.

The mountings (pressure regulator) shall be kept free of grease.

As these connections are unheated, longer drift phenomena may occur, due to contamination with traces of hydrocarbon (zero migration).

For further operation of the appliance, refer to the manufacturer's setting and operating instructions.

C.7 NO_x measurement

C.7.1 Measurement

The measurement shall be made in the connecting duct between the combustion chamber and the chimney, beyond the heat exchanger. The same sample collection is used as described in 6.7.4.

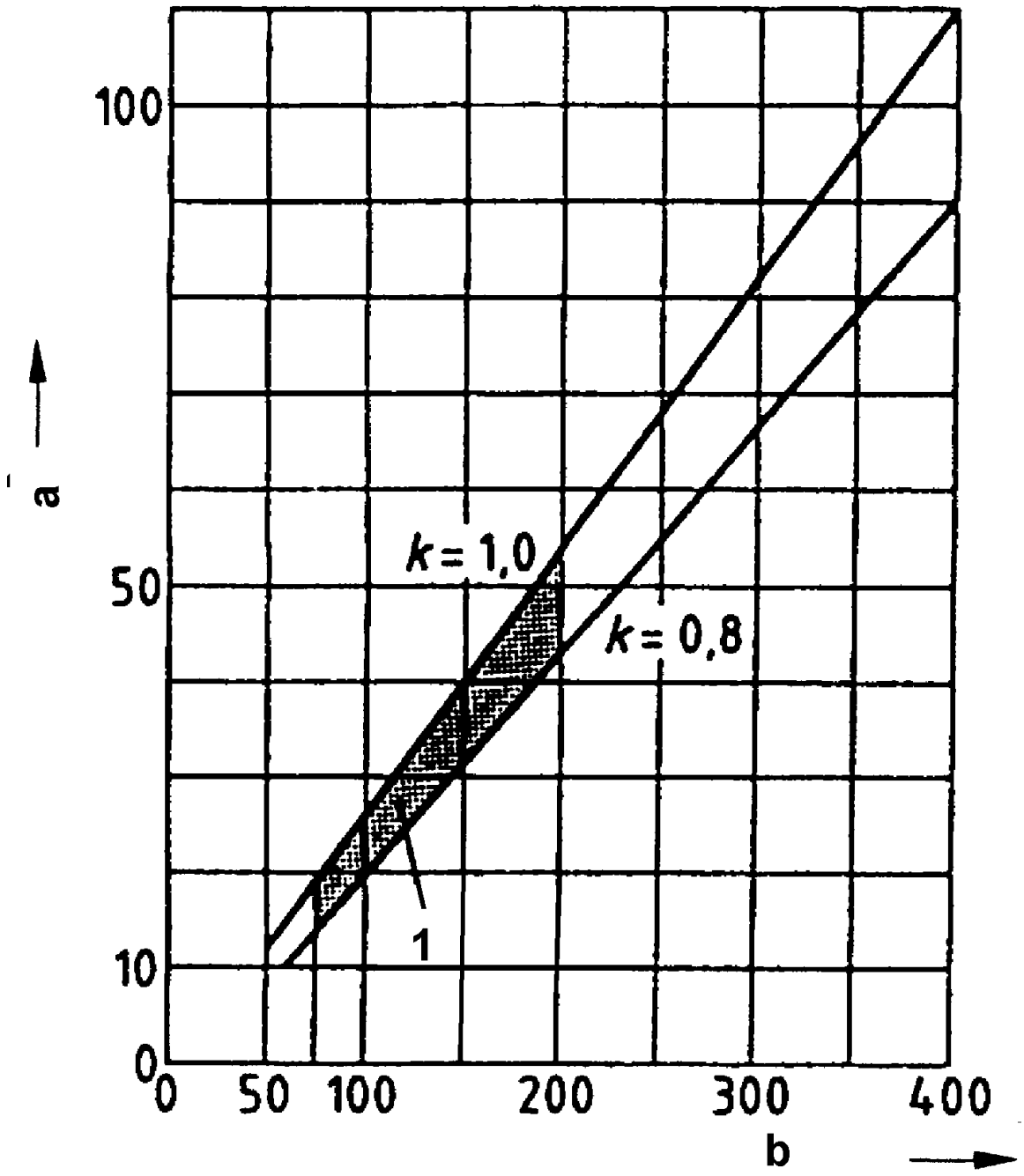
The calibration of the instrument and the proper operation of the converter (conversion rate) has to be checked in accordance with the manufacturer's instructions.

C.7.2 Evaluation of the measurement

The measured emission values shall be converted into mg/m^3 for a reference oxygen content of 3 %.

An analysis of the atomic nitrogen content of the combustibles shall be conducted. The theoretical value for atomic nitrogen of 140 mg/kg combustible, which serves as reference value, shall, however, not be exceeded.

Where a higher value is measured, the difference to the given value of 150 mg/kg shall be taken from Figure C.1 and then deducted from the value measured in 1×10^{-6} (ppm) after it has been converted to NO_2 in mg/m^3.



Key

a NO_2 in mg/m³

b Atomic nitrogen in mg/kg (combustible)

1 Most usual range

Figure C.1 – Ranges of viscosities

C.8 Conversion factors for the combustion of fuel oil for NO_x and CO

$$NO_x \text{ [mg/m³]} = NO_x \text{ [Vol.ppm]} \times 2{,}056 \times \frac{21 - O_{2_{ref}}}{21 - O_{2_{meas}}} \quad \text{(C.8)}$$

Calculated as NO_2

NO_x [mg/m³] = NO_x [Vol.ppm] × 2,03 (for 3 % O_2)

$$CO \text{ [mg/kWh]} = CO \text{ [Vol.ppm]} \times 1{,}25 \times \frac{21 - O_{2_{ref}}}{21 - O_{2_{meas}}}$$

CO [mg/kWh] = CO [Vol.ppm] × 1,26

where

$O_{2_{ref}}$ = reference gas conditions (e.g. 3 %);

$O_{2_{meas}}$ = measured O_2-concentration in the gaseous combustion products;

2,056 = the density of NO_2 in kg/m^3;

1,25 = the density of CO in kg/m^3.

Bibliography

[1] EN 60204-1, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:1997.*

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