Heat transfer systems operating with organic media
Safety requirements and testing

DIN 4754

Wärmeübertragungsanlagen mit organischen Wärmeträgern; sicherheitstechnische Anforderungen, Prüfung

Supersedes January 1980 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

This standard includes safety requirements within the meaning of the *Gerätesicherheitsgesetz* (Equipment Safety Law).

The design and construction of heat transfer systems operating with organic media require special skills. Such systems may thus only be manufactured and installed by companies that have the relevant expertise.

The content of this standard has been harmonized with the stipulations of the *Druckbehälterverordnung* (German Pressure Vessels Regulation).

The circuit diagrams included in the standard are merely simplified representations of basic circuits; they are not recommendations for particular types of circuit.

Contents

Heat transfer systems utilizing organic media, besides being covered by this standard, are also subject to the *Unfallverhütungsvorschrift* (Accident Prevention Regulation) *Wärmeübertragungsanlagen mit organischen Wärmeträgern* (Heat transfer systems operating with organic heat media) (VBG 64) issued by the employers' liability insurance associations. The present standard and VBG 64 have been coordinated in terms of content and cross reference each other in clauses where that can facilitate comprehension of the specifications.

1 Scope and field of application

This standard deals with heat transfer systems in which organic media are heated to temperatures below or above their initial boiling point at atmospheric pressure. It applies to heat consumers only in so far as the heat transfer medium passes through these.

This standard does not cover refrigerating plant[1]), heat pumps and cooling devices, portable radiators (used as individual heat sources), nor to solar heating systems with solar collectors where the heating in the circuit concerned is generated solely by solar energy.

The purpose of this standard is to provide the concrete data implicit in the safety aims described in VBG 64 and to specify methods of their technical implementation.

1) Cf. *Unfallverhütungsvorschrift Kälteanlagen, Wärmepumpen und Kühleinrichtungen* (Accident prevention regulation for refrigerating plant, heat pumps and cooling devices) (VBG 20), obtainable from *Carl Heymanns Verlag KG*, Luxemburger Straße 449, D-5000 Köln 41.

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2 Concepts

2.1 Heat transfer system

A heat transfer system is a system in which organic heat transfer media are contained in a closed circuit and in which the heat input is effected by way of heaters. It comprises all items of equipment and installations, including those stocked for replacement purposes, specified for the given mode of operation.

In heat transfer systems, the medium is heated in the heater, conducted by gravity or forced circulation to the heat consumer and is then returned to the heater for reheating (cf. figures A.1 to A.5).

2.2 Heater

Heater is a system component that is heated by fuel, flue gas, or electrically in order to heat the organic medium passing through it.

2.3 Minimum volume flow rate

In forced-circulation heaters, the minimum volume flow rate is the volume flow rate specified by the manufacturer of the system as that which must at least be maintained in order to avoid excessive overheating of the heating medium.

2.4 Permissible working pressure

The permissible working pressure is the maximum safe working pressure as specified by the client or the manufacturer.

2.5 Temperatures

For the purposes of this standard, temperatures shall be taken to refer to the different temperatures of the heating medium at the various points in the circuit (heater, heat consumer, flow and return pipes).

2.5.1 Permissible working temperature

The permissible working temperature is the maximum safe temperature of the heating medium as specified for the various components of the system by the client or the manufacturer.

2.5.2 Heating medium temperature

The heating medium temperature is the temperature of the medium in the centre of the flow section.

2.5.3 Feed temperature

The feed temperature is the temperature of the heating medium at the heater outlet.

2.5.4 Return temperature

The return temperature is the temperature of the heating medium at the heater inlet.

2.5.5 Film temperature

The film temperature is defined as the wall temperature on the heating medium side, i.e. the tube inside temperature (cf. figure B.1). Where tube walls are heated or cooled, it will deviate considerably from the heating medium temperature. The point at which the film temperature is highest is where the medium is subjected to the greatest thermal stress. The highest film temperature is, among other things, a parameter in estimations of the useful life of a heating medium (cf. subclauses 3.2.2 and 3.2.7), whereas the gradient between highest film temperature and medium temperature measured in the same plane is an essential quantity in any design assessment of a heater. See appendix B for the basis of design for fuel-fired heaters, and the footnote on page 13 for heaters heated by flue gas or electrically.

3 Safety requirements

3.1 Materials

3.1.1 The *Technische Regeln für Druckbehälter* (Codes of practice for pressure vessels) (TRB), 100 series, shall apply for the materials used to construct heaters, vessels and heat consumers.

3.1.2 The materials used for tubes shall be selected in accordance with DIN 2401 Part 12 (at present at the stage of draft), the quality of the tubes being attested by submission of at least a DIN 50 049-2.2 certificate (test report), and for high-temperature steel, by a DIN 50 049-3.1 B inspection certificate.

3.1.3 A suitable high-temperature steel (e.g. DIN 17 245 cast steel) shall be used for the casings of pumps and valves. For temperatures up to 350 °C, nodular cast iron to DIN 1693 Part 1 may also be used. In systems designed to operate at temperatures up to 200 °C, rated for a pressure of 10 bar, and having a connection of size DN 200 maximum, DIN 1691 lamellar graphite cast iron (minimum grade: GG-25) may be used for pumps and valves that are not designed for heating and cooling purposes and in which the heating medium is not heated above its boiling point at atmospheric pressure.

3.1.4 For sealing purposes, metallic packing, soft metallic glands and thermally stable soft sealants of quality It O or better, as specified in DIN 3754 Part 1, are suitable.

3.2 Construction and manufacture

3.2.1 General

Heaters, vessels and heat consumers to which the heating medium is supplied and which fall under the provisions of the *Druckbehälterverordnung*, shall be rated (TRB, 300 series) and manufactured (TRB 200 series) as pressure vessels.

Fuel-fired heaters shall be designed for a minimum pressure of 10 bar, all other heaters and vessels (including those vessels that have an open connection to atmosphere), for a minimum pressure of 2 bar, unless the design of the system requires them to be rated for a higher working pressure.

3.2.2 Heaters

The design of heaters in which a medium is heated shall ensure that the walls and the medium are at no point heated above acceptable limits, this requirement being generally satisfied by forced-circulation heaters. Where tubular coils are connected in parallel in the heater, particular care must be taken to ensure that the permissible film temperature of the medium in the separate tubes is not exceeded. Fulfilment or non-fulfilment of the requirement must be detectable at least for the parts of the heater exposed to flame impingement (e.g. by controlling the flow with the aid of flow controllers as specified in subclause 3.2.11.5) (cf. Explanatory notes).

The manufacturer of the heater shall state the temperature gradient between the highest film temperature occurring and the feed temperature and shall submit proof, at least by way of calculation, for the value of the film temperature (cf. Appendix B for guideline for the calculation of the highest film temperature in fuel-fired heaters of heat transfer systems).

If a volatile medium is heated in its liquid state and is then conducted via a device designed to reduce its pressure into an evaporator (flash tank), with the consequent separation of the liquid and vapour phases, the heater shall be designed and made in compliance with the same requirements as apply for forced-circulation heaters.

Heaters in which the medium is evaporated can generally be operated with gravity circulation. The design of such heaters, especially in the zone of the heating surfaces subjected to high loads (e.g. as a result of flame impingement), shall ensure that the bubbles of vapour forming can be released as rapidly as possible. The maximum heating surface load and the permissible operating temperature shall be compatible with the heating medium.

3.2.3 Pipework and fittings

Differential thermal expansion shall be allowed for in the design of the layout of the pipework or by installation of suitable expansion joints. Pipework and fittings shall be designed for a minimum nominal pressure of 16 bar and for the highest heating medium temperature to which they may be exposed. In the case of heating media which are operated above their boiling point at atmospheric pressure in the vapour phase, pipework and fittings shall be designed for a nominal pressure of 25 bar (cf. DIN 2401 Part 12). The piping system shall be leakproof (cf. Explanatory notes).

3.2.3.1 Welded joints

Welding shall preferably be used for jointing pipework and fittings, the joints being executed as specified in DIN 8564 Part 1 by welders who can submit proof of having qualified in accordance with DIN 8560.

3.2.3.2 Screwed joints

Screwed joints which are pressure-tight are only to be used up to size R 1 ¼ as specified in DIN 2999 Part 1, and only for devices and fittings located in parts of the system in which the temperature of the heating medium does not rise above 50 °C.

3.2.3.3 Flanged joints

Pipes, valves and fittings shall preferably be permanently jointed (e.g. by welding). However, where that is not practicable, flanged joints are permitted (e.g. joints as specified in DIN 2401 Part 12 with bolting complying with DIN 2507), such as:

a) flanges with flat face and seal (such as It seal, edged seal, spiral-wound soft material seal, graphite seal);
b) flanges with raised face;
c) flanges with tongue and groove face;
d) metal-to-metal pressure-tight joints, except for compression couplings in sizes greater than DN 25;
e) screwed joints of measuring instruments not pressure-tight on the thread.

3.2.3.4 Flexible fittings

Flexible fittings shall be welded on or connected by flanged joints, with due consideration being given to the manufacturer's instructions.

In particular, it shall be ensured that fittings such as expansion joints or flexible hoses are not concealed from view when mounted. Tubing shall be laid so as to have an adequate bending radius. Flexible metal-braided metal tubes or metal insulated tubes made from materials as specified in DIN 17440 shall be used.

3.2.3.5 Stopvalves, controllers and rotary transmission leadthroughs

All stopvalves, controllers, and rotary transmission leadthroughs used shall be of proven suitability, or this shall be documented (e.g. by presentation of the results of testing by the valve manufacturer or by an accredited expert).

An example of a proven method for sealing spindles of stopvalves and controllers is the use of bellows-type seals or the renewal of packing (cf. Explanatory notes).

3.2.4 Pumps

Pump casings shall be designed to withstand at least a rated pressure of 16 bar (cf. Explanatory notes). The shaft seals shall be of proven suitability, or this shall be documented (e.g. by presentation of the results of testing by the pump manufacturer or by an accredited expert).

Pumps with an extended cooling section (cf. [2]) have proved suitable for use in systems with the heating medium operated below its initial boiling point at atmospheric pressure.

If the bearings or shaft seals require cooling, then it shall be ensured that a warning device is actuated in case of failure of the cooling system.

Provision shall be made to ensure that any leakage of heating medium through the shaft seals is safely drained off and collected. Such heating medium is generally not suitable for reuse (cf. subclause 7.3).

The transmission of excessively high forces or moments from the pipework to the pumps shall be prevented.

In the case of media that are heated to above their boiling point at atmospheric pressure, pumps without shaft seals (e.g. canned motor pumps and magnetically coupled pumps) have proved suitable.

3.2.5 Thermal insulation

Heaters, pipework and fittings, as well as heat consumers, shall be installed in such a way that at the permissible operating temperature of the heating medium the surface temperature of neighbouring components comprising combustible materials does not exceed 85 °C. If the surface temperature of walls, supports, ceilings, or other loadbearing building elements can rise to more than 50 °C, it is to be ensured by suitable structural measures, by special thermal insulation or by provision for adequate clearances, that no damage occurs which might impair the stability of the building elements concerned. Thermal insulation shall be made from non-combustible materials (e.g. mineral fibres or glass fibre).

At points at which there is a risk of the heating medium escaping (e.g. at flanged joints and valves), the thermal insulation shall be applied so that leakages can be detected (cf. Explanatory notes).

3.2.6 Heating

Systems built to this standard shall be equipped with heating that responds quickly to control and shutdown commands. The heating equipment shall be designed for safe operation without the need for constant monitoring (for installation in workspaces, see subclause 3.3.13). This requirement may generally be deemed fulfilled in the case of electrical heating, or gas-fired or oil-fired heating or waste heat systems equipped with suitable and reliable [2]) controllers and limiters.

Furnaces designed to operate with liquid and/or gaseous fuels shall at least meet the requirements of DIN 4787 Parts 1 and 2, DIN 4788 Parts 1 to 3, while solid fuel furnaces shall meet those given in TRD 413 and TRD 414.

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2) Proof of the reliability of temperature controllers, temperature relief valves, flue gas temperature limiters, pressure relief devices, safety valves, liquid level controllers and limiters, and flow controllers shall generally be provided in the form of a type test. DIN 3440 temperature controllers and relief devices count as reliable if, on the basis of the successful completion of a type test, they have been marked with the *DIN-Prüf- und Überwachungszeichen* (DIN Testing and inspection mark) and a corresponding registration number. Details of testing laboratories for DIN 3440 devices, DIN 32728 liquid level limiters and DIN 32727 flow controllers may be obtained from the *Normenausschuß Heiz- und Raumlufttechnik* (Heating and Ventilation Standards Committee) of *DIN*, and those responsible for testing other devices, from the *Vereinigung der Technischen Überwachungs-Vereine e. V.* (Federation of Technical Inspection Offices), Kurfürstenstraße 56, D-4300 Essen 1.

Fuel-fired heaters shall be provided with a suitable safety device (e.g. in the form of a reliable [2]) flue gas temperature limiter), which can be relied upon to prevent thermal overloading of the heater by shutting down the heating.

3.2.7 Heating medium

3.2.7.1 The supplier of the heating medium shall indicate the data required for assessing its serviceability and the permissible feed temperature at which the heating medium will remain fit for use for not less than one year. This assumes that the heat transfer system has been designed in accordance with this standard and is operated properly. Due consideration is also to be given to *VDI-Richtlinie* (VDI Code of practice) 3033.

3.2.7.2 The supplier of the heating medium shall provide the manufacturer and operator of the system with details of all physical characteristics and chemical properties of the medium that are of relevance for the construction and operation of the system and for aspects of safety (cf. DIN 51 522 and DIN V 51 528). The manufacturer or supplier of the medium shall state the highest temperature that is not to be exceeded at any point in the system.

3.2.8 Expansion chamber, safeguarding against overpressure for heating media operated in their liquid phase

Expansion chambers shall be designed to accommodate at least 1,3 times the increase in volume of the filling volume occurring between the filling temperature and the permissible operating temperature above the minimum filling level.

3.2.8.1 In the case of designs as shown in figures A.1 and A.2, the expansion chamber shall be connected to atmosphere via a suitably large opening in order to prevent the occurrence of a dangerous pressure differential between expansion chamber and atmosphere. This is ensured if the cross section of the opening concerned at least meets the requirements specified in table 1 (cf. Explanatory notes).

3.2.8.2 In the case of designs as shown in figures A.3 and A.4, the expansion chamber shall be fitted with a reliable device protecting it against overpressure (e.g. safety valve, standpipe). Standpipes are permitted if the maximum gas overpressure in the expansion chamber does not exceed 0,1 bar.

See DIN 3320 Part 1 for concepts relating to safety valves.

Proof of the adequacy of the safety device (e.g. as specified in *AD-Merkblatt* (AD Instruction sheet) A 2) shall be provided by the builder of the system with respect to

a) the volume flow which the inert gas system can release in the event of failure;
b) the capacity of the filling pump in the case of overfilling;
c) the increase in volume under maximum absorbed heat.

3.2.8.3 Overflow pipes and relief devices of safety valves on expansion chambers of systems as specified in subclause 3.2.8.2 shall connect to any receiver vessel (cf. subclause 3.2.10) provided, or to another open vessel of adequate size (cf. subclause 3.2.11.7).

If the devices safeguarding against overpressure in systems as shown in figure A.3 are mounted on the receiver vessel instead of on the expansion chamber, there shall be no means of shutting off the piping connecting the expansion chamber to the receiver vessel and the pipes shall have the same nominal diameter as that given in table 1.

3.2.8.4 All system components capable of being individually shut off from the expansion chamber, such as the heater, pipework, and heat consumer, and in which the heating medium can expand as a result of heat applied from outside, shall be provided with a reliable [2]) device safeguarding against the overpressure produced thereby.

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[2]), see page 3.

3.2.8.5 Systems fitted with expansion vessels shall be provided with at least one expansion pipe connecting to the expansion vessel.

Expansion pipes shall be capable of preventing an increase in pressure of more than 10 % above the permissible working pressure of the system. They shall be sized to suit the output of the heaters, and be at least as large as specified in table 1.

Expansion pipes shall be laid in a continuous upward incline with as little lateral offset as possible. The expansion vessel is, however, not to be located directly above the furnace, except where other provision is made to prevent any heating medium escaping from coming into contact with the heater (cf. Explanatory notes).

In the case of systems which are safeguarded against overpressure only at the expansion vessel, there shall be no means of shutting off the expansion pipe, no reduction in its cross section and it shall be laid with a constant upward incline to the expansion vessel.

Table 1. **Nominal sizes for expansion and overflow pipes, and for discharge and vent pipes, as a function of heater output**

Output of heater, in kW, up to	Nominal size of expansion and overflow pipes DN	Nominal size of discharge and vent pipes DN
25	15	20
100	20	25
600	25	32
900	32	40
1 200	40	50
2 400	50	65
6 000	65	80
12 000	80	100
24 000	100	150
35 000	150	200

To receive the entire expansion volume, a small vessel may be installed in place of a large high-level expansion vessel, this small vessel having a permanently open connection to another vessel located at a point below it. In this case, the liquid level in the high-level expansion vessel shall be maintained by means of an automatic controller and a refill pump. The overflow pipe between the two vessels shall be of the same size as the relief and overflow piping of the system.

In order to avoid flow of heating medium from high-level expansion vessels with a total content of more than 1000 litres in cases of system failure, suitable measures shall be taken as illustrated in figures A.5 and A.6.

Quick-acting stopvalves (cf. figures A.5) shall be designed so as to switch off the heating once they become operative.

Fast-draining devices connecting to a receiving vessel located below it (cf. figures A.6) shall be operable from a safe position. The nominal size of the drain pipe shall be selected in accordance with table 1. It shall be run to the receiver vessel over as short a distance as possible and with a constant gradient. A fast-draining device shall be installed in the pipe which when operative switches off the heating and the circulating pump. The heating medium shall be protected against oxidation (e.g. by application of an inert gas blanket).

In the case of systems with an overlying layer of inert gas, the constant supply of gas shall be ensured. It shall be possible to monitor the pressure in the expansion chamber from the system control panel.

Liquid level indicators with glass tube, inspection glasses (except for inspection glass plates made to DIN 7081 and marked accordingly), and combustible or thermally unstable components are not to be used. Fittings must be designated by the manufacturer as suitable for the given application (e.g. for the highest heating medium temperature in the heater). In the case of systems with an open connection to atmosphere, sealable inspection pipes level with the lowest liquid level, and fuel level plungers are deemed suitable means for checking the liquid level.

The expansion chamber shall be provided with a reliable 2) device which, if the liquid drops below the minimum permissible level, will automatically switch off and lock the heating, as well as generate an optical or acoustical warning signal.

3.2.9 Expansion chambers for operating systems with heating media in their vapour phase

The design principles applying for expansion chambers in systems operating with heat media in the vapour phase differ from those applying for systems operating with liquid heating media, the size of such chambers being a function of the required evaporation volume.

The expansion chamber in such systems generally serves to separate the vapour phase of the heating medium from its liquid phase. It may be integrated in the heater or installed as a separate unit. Safety equipment shall be installed in line with the requirements specified in subclause 3.2.11.10.

3.2.10 Receiver vessels

Systems with a permissible filling volume of more than 1000 l shall be fitted with a receiver vessel for drainage purposes (cf. *Unfallverhütungsvorschrift* VBG 64) which shall be designed so as to be capable of receiving at least the volume of the largest system section that can be isolated.

Receiver vessels shall preferably be installed at the lowest point in the system and equipped with a filling level indicator or a facility for checking the filling level, as well as with drainage and vent devices. Where necessary, the vessels shall be provided with heating to avoid coagulation of the heating medium.

In the case of systems in which the heating medium is heated above its initial boiling point at atmospheric pressure, receiver vessels shall always be provided. Vapours emitted from the venting facilities shall be discharged safely, where appropriate, by way of a condenser.

In the case of systems having a low filling volume, the heater may be designed to fulfil the function of both expansion chamber and receiver vessel.

3.2.11 Equipment

3.2.11.1 Heaters, vessels and heat consumers falling within the scope of the *Druckbehälterverordnung* shall be equipped and marked in compliance with TRB 401 to 404.

The permissible working pressures indicated on the nameplates of the individual pressure vessels are a function of the permissible working pressures in the associated sections of the system and not of the rated pressure specified in subclause 3.2.1.

Vessels that are not covered by the *Technische Regeln für Druckbehälter* because they have an open connection to atmosphere (e.g. expansion vessels and receiver vessels) shall be provided with a nameplate on which a permissible working pressure is not stated.

3.2.11.2 A temperature measuring instrument shall be mounted in the flow pipe and a pressure gauge in the return pipe.

In the case of closed systems, the expansion chamber shall be provided with a reliable 2) pressure relief device which, when operative, is to switch off and lock the heating as well as generate an optical or acoustic warning signal. The pressure must be set at a lower value than the response pressure of the safety valve.

3.2.11.3 The electrical components of pressure relief devices, as well as the associated auxiliary power circuits, shall not be connected on the open-circuit principle, unless in conjunction with an ambivalent connection. Pneumatic or hydraulic control circuits downstream of the relief devices shall be designed so that the switching off and locking functions are ensured even if the control power is interrupted. The devices shall, if the permissible limiting value is exceeded, switch off and lock the heating as well as generate an optical or acoustic warning signal.

Heaters in which an unacceptably high heating medium temperature can occur shall be fitted near the flow nozzle or in the flow pipe at the outlet from the heater with a reliable 2) temperature controller and a reliable 2) DIN 3440 temperature relief valve. Controllers and relief devices shall have transmitting devices that are independent of each other (cf. Explanatory notes). These devices may also be installed elsewhere to control individual heat consumers.

3.2.11.4 In the case of forced-circulation heaters in which the failure of a pump may lead to an excessive rise in the temperature of the heating medium, two pumps, one in reserve, of adequate capacity shall be provided. The operation of these pumps shall be by way of two mutually independent power sources. The pumps shall also continue to function after each shutdown of the heating for as long as is needed to ensure that there is no risk of the medium being heated excessively. This does not apply to cases where the fast-shutdown device specified in subclause 3.2.8.5 is actuated.

One pump and one power source are sufficient if no undue rise in temperature of the heating medium can occur in the event of the pump failing (e.g. by largely dispensing with masonry linings that act as heat accumulator). The pump shall in all cases be connected in such a way that the heating is switched off and locked when it ceases to operate.

Dirt traps with removable trays or reversible dirt traps are to be installed in front of the pumps. If a number of pumps share a single suction pipe, it is sufficient for one dirt trap to be installed in that pipe.

3.2.11.5 In the case of forced-circulation systems in which a reduction in flow may give rise to an excessive rise in temperature of the heating medium, a reliable 2) flow controller shall be installed which, if the minimum flow rate through the heater is not maintained, shuts off and locks the heating and generates an optical or acoustical warning signal (cf. *Unfallverhütungsvorschrift* VBG 64).

The volume flow rate or the highest film temperature shall be monitored in the case of heaters with an output of up to 50 kW, for higher outputs, they must be measured and indicated (cf. Explanatory notes). On start-up, it shall not be possible to switch on the heating until the circulating pump has become operational.

In the case of a cold start, the flow controller may be bypassed until the heating medium has attained a viscosity corresponding to the setting of the controller. By-passing may only be effected by means of a supplementary reliable 2) limiter or of another non-locking control. While by-passing is effective, controllable furnaces shall only be operated at their low load range.

In some cases, it may be expedient to install a closable short-circuit between flow and return sides of the heater as a means of reducing the cold start time for the heater.

3.2.11.6 *Unfallverhütungsvorschrift* VBG 64 states that, in order to prevent the escape of larger quanitities of organic heating medium, supplementary stopvalves in the flow and return pipes are to be installed in systems containing more than 5 t of liquid and that these must be operable from a position of safety.

For 2), see page 3.

As a function of the size and design of the system, the provision of further stopvalves is recommended (cf. Explanatory notes).

3.2.11.7 Vessels with an open connection to atmosphere shall be equipped with vent pipes as specified in table 1. Vapours emerging from these shall be discharged safely. Such vessels shall be regularly inspected to ensure that water is not present.

3.2.11.8 It is to be ensured that the heating medium is, as a function of the operational and safety requirements, of sufficiently low viscosity (e.g. by provision of trace heating).

3.2.11.9 Heat consumers that are heated by means of a heating medium (e.g. counter flow devices, evaporators, air heaters) shall be designed and built so that the heating medium can neither enter the product nor the product enter the medium (e.g. by welding pipes to tube plates).

If products are heated which have a corrosive effect on the heating surface, appropriate corrosion protection measures shall be implemented.

3.2.11.10 Equipment of expansion chambers, receiver vessels and heaters in systems operating with heating media in the vapour phase.

The requirements to be met by the equipment of expansion chambers, receiver vessels and heaters in systems operating with heating media in the vapour phase derive from TRB 401 to 404; in the range of equipment are included:

1. excess pressure indicators;
2. pressure relief devices;
3. pressure gauges;
4. temperature relief devices [3]);
5. liquid level gauges;
6. feed devices for making up heating medium;
7. liquid level limiters.

Systems in which the return of condensate to the heater is not effected directly via gravity but via a condensation tank, shall be equipped with feed pumps.

When the safety valve is actuated, heating medium in the vapour phase escapes. This shall be liquefied via a condenser and be cooled down until it can safely be drawn off to the receiver vessel. The size of the condenser shall be such that it can condense the entire quantity of medium escaping from the valve.

3.2.12 Electrical equipment

3.2.12.1 Electrical systems on industrial premises in which heaters, receiver vessels, pumps or other machines and apparatus containing heating media are installed shall comply with the specifications given in the DIN VDE 0100 series of standards (cf. *Unfallverhütungsvorschrift* VBG 64, clause 11).

3.2.12.2 The electrical equipment, such as wiring or switches, shall be laid in the danger zone (e.g. near flanged joints) so that it is protected against the action of the heating medium in the event of its escaping e.g. by shielding or by concealed installation of the equipment (cf. *Unfallverhütungsvorschrift* VBG 64, clause 11).

3.2.12.3 Electrical trace heating shall be designed and laid so that there is no risk of the heating medium igniting. They shall switch off automatically when the prescribed temperature is reached. Such heating shall also be laid so as to be protected from external influences (cf. *Unfallverhütungsvorschrift* VBG 64, clause 11).

3.2.12.4 At an easily accessible and safe location, an emergency switch shall be installed governing those items of electrical equipment, including the heating, which would represent a source of danger if they were to continue to operate under system failure conditions (cf. *Unfallverhütungsvorschrift* VGB 64, clause 11).

Equipment which must continue to operate even in the event of system failure (e.g. escape route lighting), shall be safeguarded against explosion hazards.

3.3 Heater installation

3.3.1 General

For heaters used in a given fixed location, the following specifications with respect to installation will, depending on the approval procedures applying in the individual German *Länder*, and as a function of the total nominal thermal output, need to be observed.

Installation below or above rooms designed for occupation is not permitted.

Where solid, liquid or gaseous fuels are used, the system, as a function of the thermal output of the furnace and where the *Verordnung über genehmigungsbedürftige Anlagen* (German Regulation on systems subject to mandatory approval) is applicable, must be approved with regard to pollution control, in addition to the procedure to be implemented to obtain building inspectorate approval (agrément).

The installation of the heaters in work spaces shall permit any heating medium escaping from the system to be collected and discharged safely.

If the formation of a potentially explosive atmosphere in the room in which the heater is installed cannot be precluded, measures as specified in paragraph 2 of clause 5 of *Unfallverhütungsvorschrift* VBG 64 shall be implemented (cf. Explanatory notes).

Portable, electrically heated heat transfer systems that are not designed to fulfil a given function in a given location are not subject to any approval procedure under building regulations.

3.3.2 Installation in heating rooms

Heating rooms shall comply with the relevant building regulations and the relevant heating regulations of the German *Länder*.

Heating rooms for fuel-fired heaters shall be ventilated and vented continuously when the heaters are in operation (cf. Eplanatory notes).

The installation of heaters and vessels in the same room is deemed safe.

The design of heating rooms shall ensure that any heating medium escaping from the system is collected and discharged safely. Gullies (floor drains) shall be equipped with a shut-off device. In the room in which the heater is installed a sign made of durable material shall be mounted, bearing the following inscription:

Keep gully closed **at all times.**

Only to be opened to **drain off water!**

Receiver tanks have proved suitable for the safe discharge of heating medium escaping from the heater.

3.3.3 Installation in work spaces

By way of departure from subclause 3.3.2, heaters may be installed in work spaces, assuming the permission of the building inspectorate, the trade inspection authorities, and the responsible employers' liability insurance association has been obtained. The installation of a fuel-fired heater in work spaces requires a legal exemption in accordance with the regulations applying in the given German *Land*, which

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3) Cf. *Merkblatt* (Instruction sheet) ZH 1/201 issued by the *Hauptverband der gewerblichen Berufsgenossenschaften* (Federation of the Employers' Liability Insurance Associations), obtainable from *Carl Heymanns Verlag KG*, Luxemburger Straße 449, D-5000 Köln 41.

correspond to paragraph 2 of clause 7 of the *Musterfeuerungsverordnung* (Model Heating Regulation), as amended in September 1987. Besides that, the installation of fuel-fired heaters with a total thermal output of more than 50 kW outside heating rooms is only permitted by way of an exemption or dispensation in accordance with the regulations applying in the given *Land*, which correspond to paragraph 9 of clause 7 of the *Musterfeuerungsverordnung*. Such an exemption may be granted if required for operational reasons, and if it is ensured that any heating medium escaping cannot ignite or be caused to explode, and if the nature of the operation and the rooms in which the heater is installed are deemed safe. This is generally the case when, during operation, the heater is under continual observation by a qualified person and when the total content of the heater, plus two-thirds of the content of the expansion vessel, does not exceed 500 l for fuel-fired heaters, and 5000 l for electrical heaters.

Application for approval shall be made early enough for the responsible authority (building inspectorate, trade inspection office) to be able to influence the project.

Heaters are only to be installed in work spaces if the heat transfer systems also meet the following requirements.

a) The heaters in the work spaces shall be installed in such a way that any heating medium escaping may be collected and discharged safely.
b) From every point in the work space two escape routes must lead into the open air, at least one of which shall not be longer than 25 m to the open air, to the stairwell or to rooms offering an equivalent level of safety.
c) The work space and the installation of the heaters shall comply with the guidelines for the installation of furnaces with a total nominal thermal output of more than 50 kW in rooms other than heating rooms (cf. Explanatory notes).

3.3.4 Open air installation

For heaters installed in the open air, the guidelines for the installation of furnaces with a total nominal thermal output of more than 50 kW in rooms other than heating rooms shall be applied by analogy.

3.4 Protection against accidental contact and fire protection

3.4.1 Protection against accidental contact

Parts of heat transfer systems with a surface temperature in excess of 110 °C shall be cladded with non-combustible material if there is a risk of accidental contact. This cladding shall be fixed permanently and be so shaped that no objects can be placed or left on it.

3.4.2 Fire protection

An adequate number of fire extinguishers satisfying the requirements for fire class B as specified in DIN 14 406 Part 1 shall be kept ready for use near to heaters. [3])

In the immediate surroundings of heaters, vessels, pumps and heat consumers, automatic fire extinguishing equipment operating with water (e.g. sprinkler equipment with a uniform array of spray nozzles) shall be installed so that water cannot come into contact with burning heating medium. Permanent signs shall be located within easy reading distance of heat transfer systems, bearing the following inscription:

Danger!

Do not use water to extinguish burning heating medium!

3.4.3 Safe removal of low-boiling constituents

If low-boiling constituents of the heating medium can accumulate in quantities representing a hazard, then measures (e.g. as shown in figures A.1 to A.4, or provision for their discharge to the open air) shall be taken which either ensure their safe dissipation or provide for inert conditions in the expansion vessel.

4 Initial inspection and routine inspections

Details of inspection are specified in the *Druckbehälterverordnung*. The most important requirements are described below for the information of the users of this standard.

4.1 Pressure vessels

Inspection of heaters, vessels, system components, and apparatus which fall under the *Druckbehälterverordnung* shall be carried out on the basis of the criteria specified there. If they do not fall under that regulation, the client or his representative shall indicate to the supplier on ordering that the pressure vessels as supplied must comply with the requirements of the *Druckbehälterverordnung*. Pressure vessels that are not required to be inspected by an expert for acceptance purposes shall not be commissioned until they have been subjected successfully to an acceptance inspection by a qualified person.

In addition to the routine inspections prescribed in the *Druckbehälterverordnung*, the operator is also obliged to have the system inspected under operating conditions once a year by a duly qualified person of his designation. This inspection shall comprise the entire system. Where appropriate, such monitoring shall be placed on a contractual basis.

For the above purposes, the operator of the system shall provide the person performing the inspection with the necessary data. Any defects discovered are to be made good as directed by the inspector.

4.2 Heating medium

As stated in the *Druckbehälterverordnung*, the heating medium is to be inspected for its serviceability by a qualified person at least once a year, and otherwise as required (e.g. when the mode of operation is changed). Reuse of the medium is only permissible if the results of the inspection so indicate (cf. implementing regulations pertaining to clause 19 (3) of *Unfallverhütungsvorschrift* VBG 64).

For the inspection of the heating medium, a specimen, preferably of 1 litre, shall be taken from the main stream of the hot system by means of a specimen cooler, or by other means where the temperature of the main stream is less than 100 °C. The specimen shall be sealed immediately after it has been removed, and kept sealed.

The operator shall provide the following information:

a) age of filling;
b) maximum feed temperature;
c) top-up quantity at last inspection.

5 Inspection log

An inspection log shall be kept for each system, which shall record the result of the original tightness inspection prior to commissioning, the results of the inspections subsequent to commissioning and restarts, the results of the annual system inspections, results of the heating medium inspection and of any repair carried out (cf. *Unfallverhütungsvorschrift* VBG 64).

6 Operating instructions

The manufacturer shall supply operating instructions for the heat transfer system that meet the requirements of DIN V 8418. These instructions shall contain, among other information, the following particulars:

a) name and address of system manufacturer;
b) name, address and telephone number of customer service;

For [3]), see page 6.

c) trade name and safety characteristics of heating medium and the filling quantity required for normal operation;

d) instructions on how to fill, start and shut down the system;

e) details of emergency shutdown procedure.

According to *Unfallverhütungsvorschrift* VBG 64, the operator is to prepare the operating manual on the basis of the present standard, taking due account of the operating instructions.

7 Maintenance and repair

7.1 Control and safety devices shall be inspected for efficient operation (cf. table 1 of *VDI-Richtlinie* 3033).

7.2 Repairs to the heat transfer system, and the filling, refilling and taking of specimens of heating medium shall only be undertaken by suitably trained and qualified persons (cf. clause 5 of TRB 700 for details of measures relating to installation and maintenance).

7.3 Heating medium that has escaped from the system shall only be returned to it after its continuing serviceability has been verified.

7.4 Welding work shall only be carried out on system components when combustible vapour/air mixtures have been removed by flushing with inert gas, and if this flushing process is kept up during the course of the work (cf. *Unfallverhütungsvorschrift Schweißen und Schneiden* (Accident prevention regulation on welding and cutting) (VBG 15)).

7.5 Saturation of the thermal insulation by the heating medium (wick effect) gives rise to an increased fire hazard, and due allowance shall be made for this when selecting and placing the thermal insulation material. Saturated insulation material is not to be reused.

Appendix A

Diagrams of heat transfer systems

(examples only, not intended to be exhaustive)

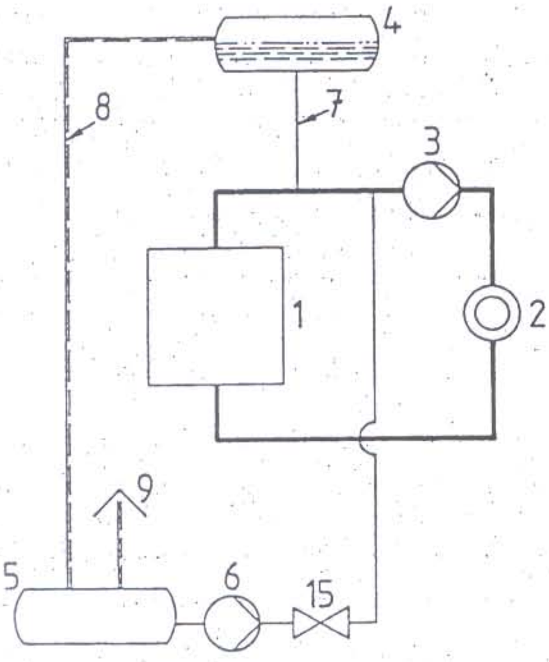


Figure A.1. Diagram of a system with an open connection of the expansion chamber to atmosphere

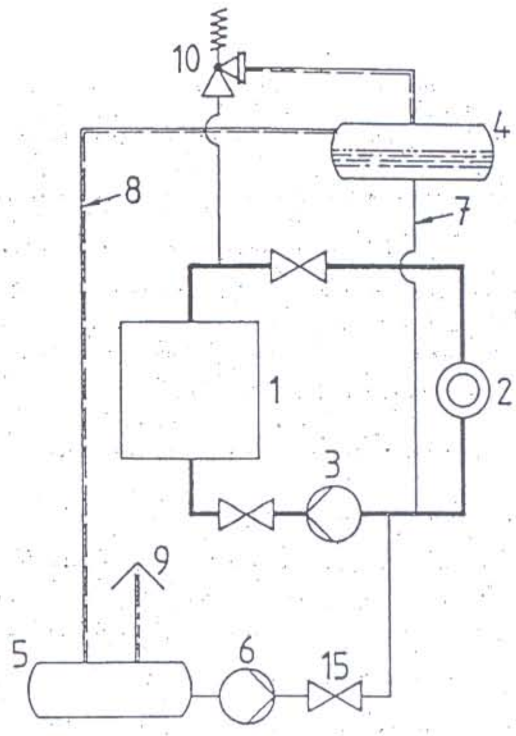


Figure A.2. Diagram of a system with an open connection of the expansion chamber to atmosphere, but with a heater that can be isolated

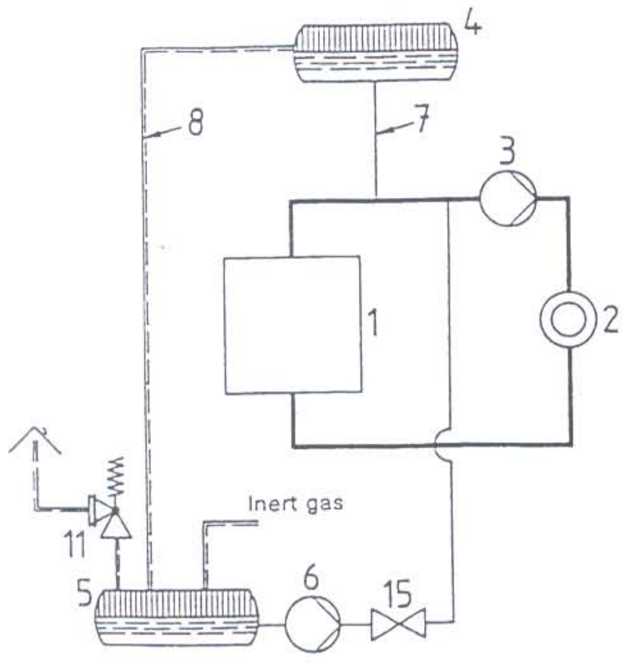


Figure A.3. Diagram of a system with inert gas blanket in expansion chamber and receiver vessel

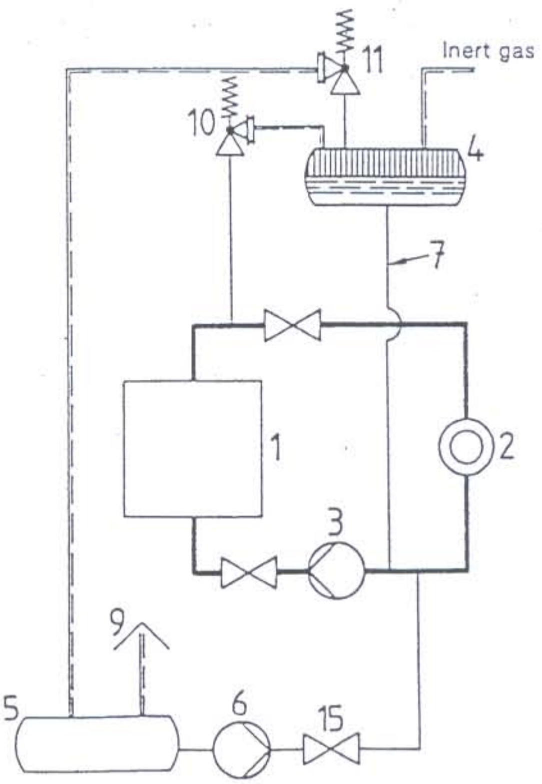


Figure A.4. Diagram of a system with inert gas blanket in expansion chamber and with a heater that can be isolated (cf. Explanatory notes, item 10)

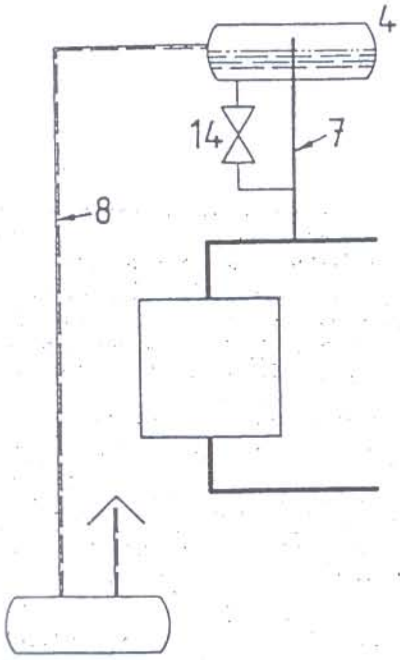


Figure A.5. Safety circuit for systems with a high-level expansion vessel with a total capacity of more than 1000 l providing for a shut-off facility to be actuated in the event of a hazard occurring (14). End of expansion pipe (7) here lies above the maximum filling level in the expansion vessel (4) (basic system as per figure A.1)

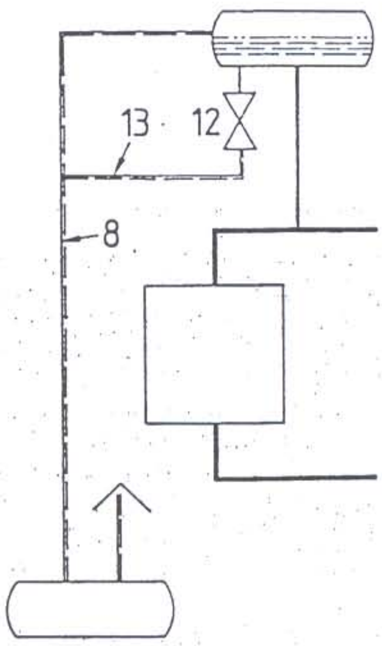
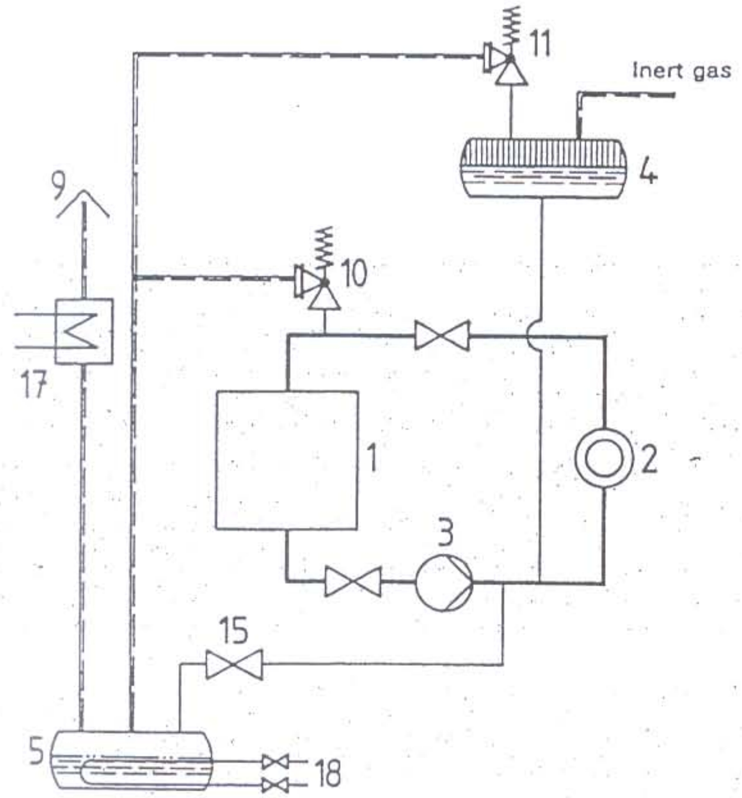


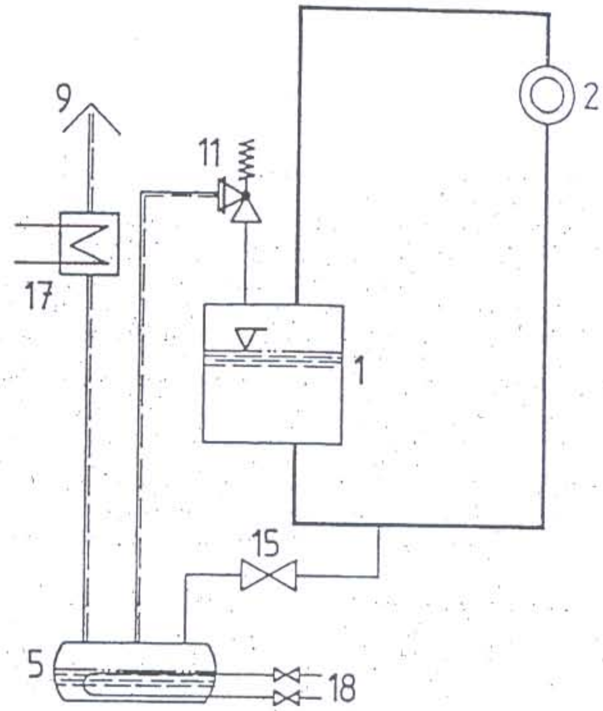
Figure A.6. Safety circuit for systems with a high-level expansion vessel with a total capacity of more than 1000 l providing for a fast-draining device (12) to be actuated in the event of a hazard occurring (basic system as per figure A.1)

Key to figures A.1 to A.7

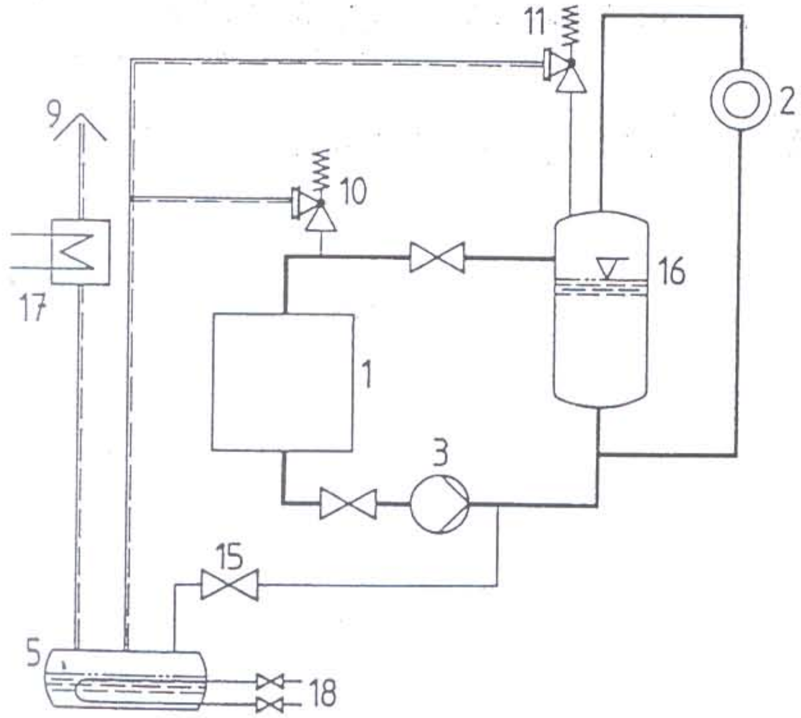
1 Heater (cf. subclauses 3.2.2, 3.2.3 and 3.2.11.10)
2 Heat consumer (cf. subclauses 3.2.1 and 3.2.11.9)
3 Circulating pump (cf. subclauses 3.2.4 and 3.2.11.4)
4 Expansion vessel (cf. subclause 3.2.8)
5 Receiver vessel (cf. subclauses 3.2.10 and 3.2.11.10)
6 Filling and draining pump
7 Expansion pipe (cf. subclause 3.2.8.5)
8 Overflow pipe (cf. subclause 3.2.8.3)
9 Venting (connection to open air) (cf. subclause 3.2.11.7)
10 Safety valve (cf. subclauses 3.2.8.4 and 3.2.11.10)
11 Safety valve (cf. subclauses 3.2.8.2 and 3.2.11.10)
12 Fast-draining device (cf. subclause 3.2.8.5)
13 Fast-drainage pipe (cf. table 1 for nominal size)
14 Shut-off facility (cf. subclause 3.2.8.5)
15 Drain valve
16 Flash tank (cf. subclause 3.2.5)
17 Cooler (cf. subclause 3.2.11.10)
18 Heating (cf. subclause 3.2.11.8)



a) System with circulating fluid



b) System with gravity circulation (vapour phase)



c) Heating medium heated in forced-circulation, with vapour generation in flash tank.
Heating of consumer in gravity circulation.

Figure A.7. Diagram of systems in which the heating medium is heated above its boiling point at atmospheric pressure

Appendix B

Guideline for the calculation of the highest film temperature in fuel-fired heaters of heat transfer systems

As an aid in the calculation of the highest film temperature in the heater of heat transfer systems, Code of practice MB 6 was prepared by a working group of the *Fachverband Dampfkessel-, Behälter- und Rohrleitungsbau e. V.* (German Steam Boiler, Vessel and Pipework Construction Association), with whose kind permission the complete text of the code is reproduced here (cf. Explanatory notes).

The field of application of this guideline (clause 1 of the following text) does not imply any limitation of that of the present standard.

The code of practice was elaborated in the form of an instruction sheet jointly by Working Group *Filmtemperatur* of the heat transfer system manufacturers organized in the above association and the *Technischer Überwachungsverein Bayern e. V.* (*Bayern* Technical Inspection Office).

Departures from the code are permitted where these can be justified by corresponding test results or analysis.

Contents

B.1 Field of application

This code applies for DIN 4754 heat transfer systems. It serves to calculate the highest film temperature (i.e. highest tube inside wall temperature) in fuel-fired heaters in which the heating medium is present in its liquid phase.

B.2 General

The calculation procedure is based on the assumption that

a) the heater concerned is assembled from components essentially consisting of heating surfaces in the form of tubes in which circulation is effected by forced flow;

b) the combustion chamber is circular in cross section and its size and design is such that the flame comes into contact with the walls neither across nor along its body;

c) the maximum density of heat flow rate in the combustion chamber occurs at the circumference and that this is designed and manufactured to comply with subclause 3.2.2 of DIN 4754.

B.3 Symbols, quantities and units

Symbol	Quantity	Unit
c_p	specific isobaric thermal capacity at $\bar{\vartheta}$	J/(kg · K)
d_a	tube outside diameter	m
d_F	flame diameter	m
d_i	tube inside diameter	m
f	factors	—
$\dot{q}$	maximum density of heat flow rate	W/m^2
$\bar{w}_i$	mean flow rate of heating medium	m/s
C_s	black body radiation constant	W/(m^2 · K^4); C_s = 5,67 W/(m^2 · K^4)
D	mean diameter of combustion chamber	m
L	effective straight tube length	m
Pr	Prandtl number $Pr = \frac{c_p \cdot \eta}{\lambda}$	
Re	Reynold's number $Re = \frac{\bar{w}_i \cdot d_i}{v}$	
T_F	flame temperature	K
T_W	pipe wall temperature = $\vartheta_a + 273{,}15$	K
α_i	heat transfer coefficient of heating medium	W/(m^2 · K)
ε_{FW}	emissivity (flame/wall)	—
η	dynamic viscosity at $\bar{\vartheta}$	Pa · s
$\bar{\vartheta}$	mean heating medium temperature at point of maximum density of heat flow rate	°C
ϑ_a	tube wall outside temperature	°C
ϑ_i	maximum heating medium temperature at tube wall inside	°C
$\Delta\vartheta$	temperature increase at thermal interface	K
λ	thermal conductivity at $\bar{\vartheta}$	W/(m · K)
v	kinematic viscosity at $\bar{\vartheta}$	m^2/s

B.4 Notation

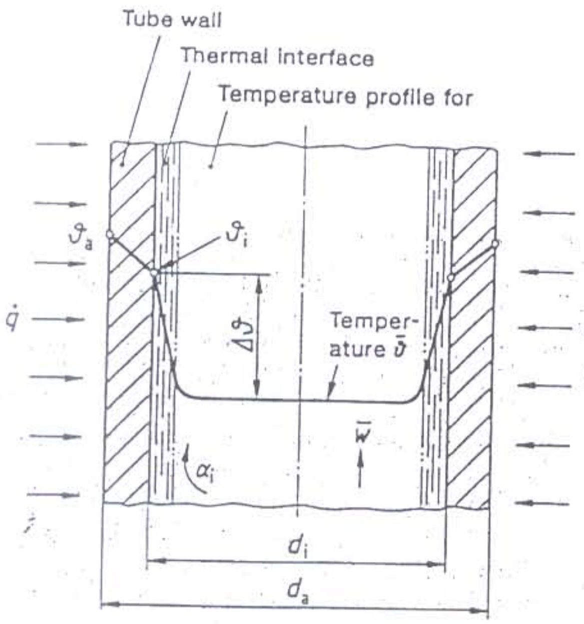


Figure B.1 Heating medium temperature profile in heated tube

B.5 Requirement

The heat flow applied to the tube wall by way of the flame and flue gases shall be dissipated by the heating medium in such a way that the permissible film temperature at the tube wall is not reached and the initial boiling point not exceeded.

B.6 Calculation procedure

B.6.1 Determination of highest film temperature*)

From the equation

$$\Delta\vartheta = \frac{\hat{\dot{q}}}{\alpha_i} \cdot \frac{d_a}{d_i} \cdot f_0 \tag{1}$$

with $f_0 \approx 0{,}9$, to allow for the tangential heat loss in tube wall,

the highest film temperature is obtained as

$$\hat{\vartheta} = \bar{\vartheta} + \Delta\vartheta \tag{2}$$

This temperature is not to exceed the maximum permissible film temperature specified by the heating medium manufacturer.

$$\hat{\vartheta}_i \le \vartheta_{zul} \tag{3}$$

B.6.2 Determination of the heat transmission coefficient at inside tube wall

For the heat transmission in a tube in which a fluid runs in turbulent flow, the following equation applies [1]:

$$\alpha_i = f_1 \cdot \frac{\lambda}{d_i} \cdot 0{,}012 \cdot Re^{0{,}87} \cdot Pr^{0{,}4} \tag{4}$$

in which factor f_1 ($\approx 0{,}8$) allows for the influence of tube bends and the direction of heat flow [2].

The equation is valid for:

$10^4 < Re < 10^6$

$1{,}5 < Pr < 500$

$d_i \ll L$

B.6.3 Determination of density of heat flow rate

For the density of heat flow rate in a cylindrical combustion chamber, the following equation applies [2]:

$$\hat{\dot{q}}_0 = f_2 \cdot \frac{d_F}{D} \cdot \varepsilon_{FW} \cdot C_s \left[\frac{T_F^4}{100} - \frac{T_W^4}{100} \right] = f_2 \cdot \hat{\dot{q}}_F; \tag{5}$$

For ε_{FW}, see figure B.3 and for $\hat{\dot{q}}_F$, see figure B.4.

Factor f_2 ($\approx 1{,}15$) allows for the convection component and the gas edge radiation component.

$$\hat{\dot{q}} = f \cdot \hat{\dot{q}}_0$$

For f, see figure B.5.

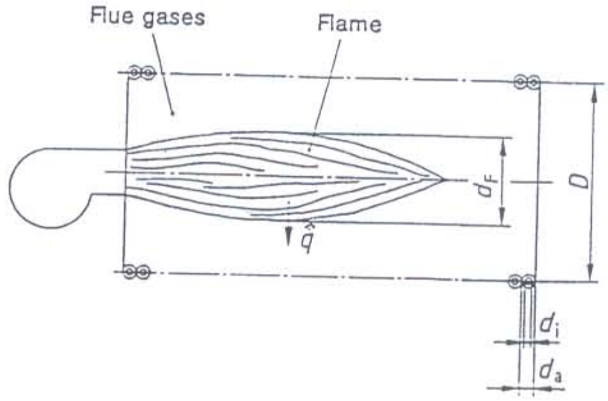


Figure B.2 Diagram of combustion chamber

*) $\Delta\vartheta = \dfrac{\hat{\dot{q}}}{\alpha}$ (basic equation for electrically heated and flue gas heated heaters).

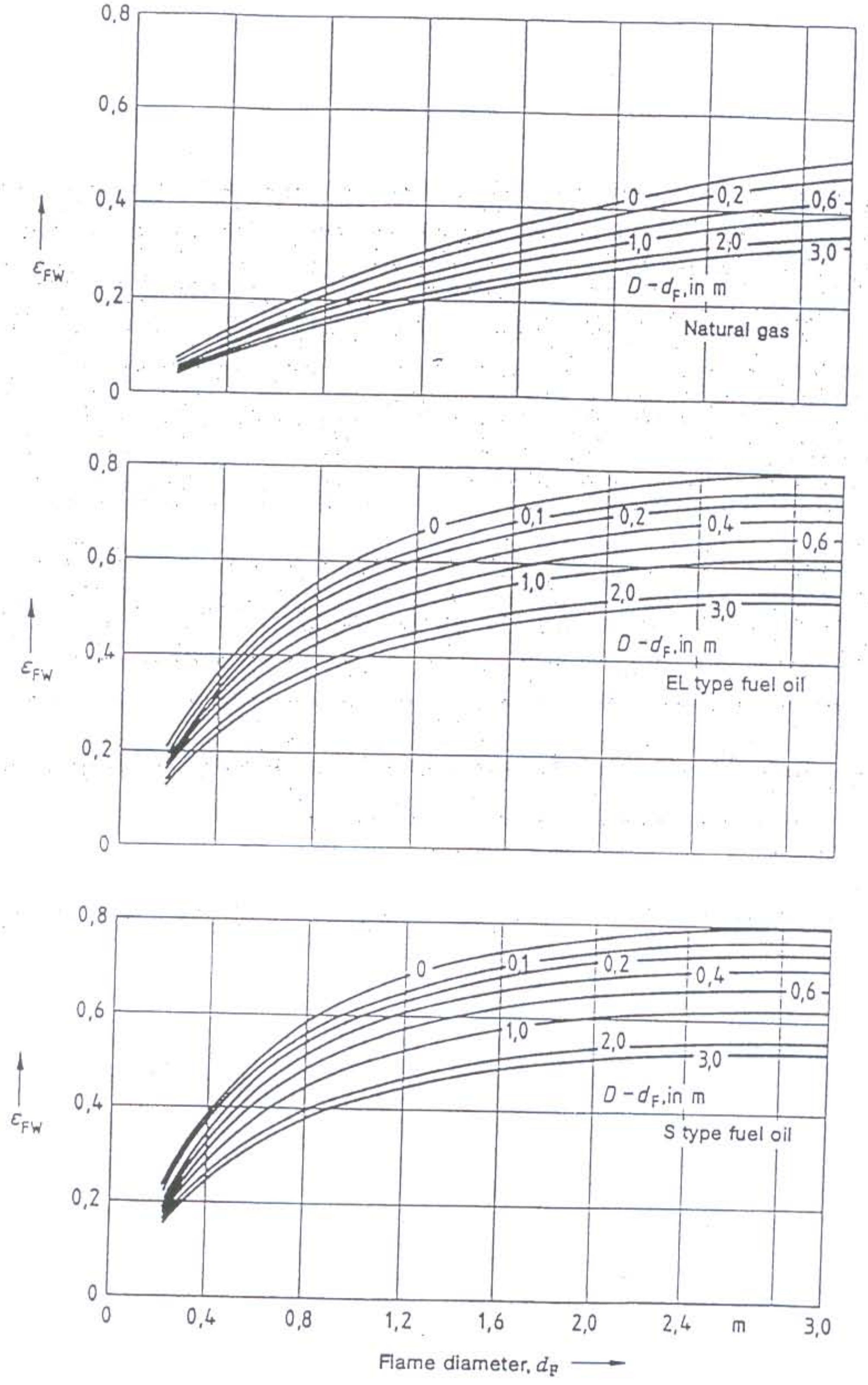


Figure B.3. Emissivity, ε_{FW}, between flame and cooled wall

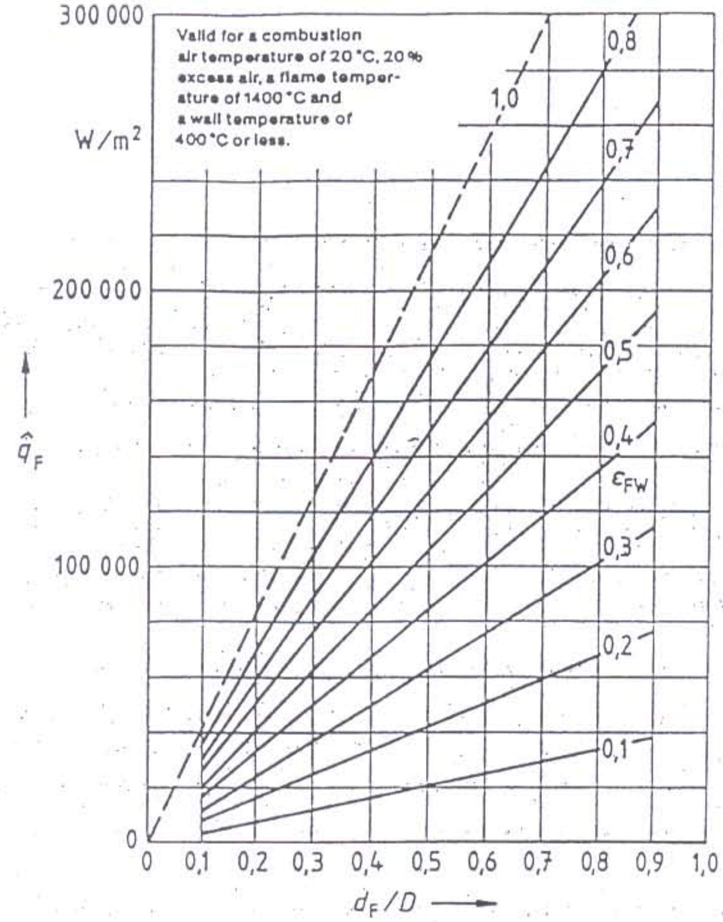


Figure B.4. Density of heat flow rate $\hat{q}_F$ as a function of d_F/D

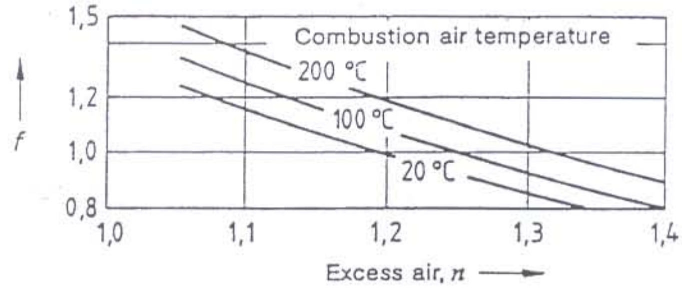


Figure B.5. Correction factor f (approximation) for density of heat flow rate with different excess air ratio and with preheated combustion air

Appendix C

Description of system for purposes of obtaining approval for the construction and operation of a DIN 4754 heat transfer system

Applicant ______________________________
(name, company, address)

Operator ______________________________
(name, company, address)

Place of installation ______________________________
(location, road and house number)

Manufacturer of system ______________________________
(name, company, address)

Total thermal output of system ______________________________ kW

Number of heaters ______________________________

C.1 Data on heater nameplate

Manufacturer/supplier ______________________________

Serial number ______________________________

Year of construction ______________________________

Permissible working pressure ______________________ bar

Permissible operating temperature ______________________ °C

Capacity ______________________ litres

Output ______________________ kW

Minimum volume flow rate ______________________ m^3/h

Component identification mark ______________________________

C.2 Data on expansion vessel nameplate

Manufacturer/supplier ______________________________

Serial number ______________________________

Year of construction ______________________________

Permissible working pressure ______________________ bar

Permissible operating temperature ______________________ °C

Capacity ______________________ litres

Component identification mark ______________________________

C.3 Data on the nameplate of the receiver vessel

Manufacturer/supplier ______________________________

Serial number ______________________________

Year of construction ______________________________

Permissible working pressure ______________________ bar

Permissible operating temperature ______________________ °C

Capacity ______________________ litres

Component identification mark ______________________________

C.4 Data on nameplate of heat consumers (heating medium side)

No. 1

Designation ______________________________

Manufacturer/supplier ______________________________

Serial number ______________________________

Year of construction ______________________________

Permissible working pressure ______________________ bar

Permissible operating temperature ______________________ °C

Capacity ______________________ litres

Component identification mark ______________________________

No. 2

Designation ______

Manufacturer/supplier ______

Serial number ______

Year of construction ______

Permissible working pressure ______ bar

Permissible operating temperature ______ °C

Capacity ______ litres

Component identification mark ______

No. 3

Designation ______

Manufacturer/supplier ______

Serial number ______

Year of construction ______

Permissible working pressure ______ bar

Permissible operating temperature ______ °C

Capacity ______ litres

Component identification mark ______

No. 4

Designation ______

Manufacturer/supplier ______

Serial number ______

Year of construction ______

Permissible working pressure ______ bar

Permissible operating temperature ______ °C

Capacity ______ litres

Component identification mark ______

No. 5

Designation ______

Manufacturer/supplier ______

Serial number ______

Year of construction ______

Permissible working pressure ______ bar

Permissible operating temperature ______ °C

Capacity ______ litres

Component identification mark ______

C.5 Equipment

C.5.1 Data on system nameplate

System manufacturer ______

Manufacturer or supplier of heating medium ______

Designation of heating medium ______

Permissible feed temperature of heating medium ______ °C

Filling volume ______ litres

C.5.2 Temperature relief valves

Number ______

Manufacturer ______

Shut-off temperature ______ °C

Component identification mark ______

C.5.3 Flue gas temperature limiters

Number ______

Manufacturer ______

Shut-off temperature ______ °C

Component identification mark ______

C.5.4 Flow controllers

Number ______

Type**) ______

Manufacturer ______

Minimum volume flow rate ______ m^3/h or bar***)

Component identification mark ______

C.5.5 Liquid level limiters (expansion vessel)

Manufacturer ______

Component identification mark ______

**) See document detailing flow control.

***) Delete as applicable.

C.5.6 **Safety valves**

1	2	3	4	5	6	7
Number	Manufacturer	Identification	a) Type(s) b) Type of loading c) Body materials (standard designation)	a) Nominal size b) Smallest valve port area, in mm c) Minimum free flow area, in mm² d) $\frac{\alpha}{1{,}1}$	Place of installation	Response pressure set

C.5.7. **Pressure-relief valves for closed systems**

Manufacturer ____________________

Response pressure set ____________________ bar

Place of installation ____________________

Identification ____________________

C.5.8 **Safety circuit for systems with a high-level expansion vessel with a total capacity of more than 1000 l**

Type of circuit as in figure 5 or 6****) ____________________

Manufacturer ____________________

Material of pressure-containing parts ____________________

Pressure rating (PN) ____________________

Nominal size (DN) ____________________

C.5.9 **Details of heating**

Manufacturer ____________________

Energy ____________________

Additional heating by flue gas (yes/no) ____________________

Additional electric heating (yes/no) ____________________

Description (to be given on an enclosure)

C.5.10 **Circulating pumps**

Number ____________________

Type ____________________

Manufacturer ____________________

Flow rate ____________________ m^3/h

Head ____________________ m

Pressure rating (PN) ____________________

Forced cooling required/not required***) ____________________

C.5.11 **Return pipe pressure gauges**

Nominal range ____________________ bar

C.5.12 **Flow pipe thermometers**

Nominal range ____________________ °C

C.5.13 **Temperature controllers**

Manufacturer ____________________

Shut-off temperature ____________________ °C

Identification ____________________

For ***), see page 17.

****) To be specified by manufacturer.

Standards of the DIN VDE 0100 series Erection of power installations with rated voltages up to 1 kV

AD-Merkblatt A2 *Sicherheitseinrichtungen gegen Drucküberschreitung; Sicherheitsventile* (Pressure relief devices; safety valves)

Unfallverhütungsvorschrift VBG 15 *Schweißen und Schneiden*

Unfallverhütungsvorschrift VBG 20 *Kälteanlagen, Wärmepumpen und Kühleinrichtungen*

Unfallverhütungsvorschrift VBG 64 *Wärmeübertragungsanlagen mit organischen Wärmeträgern*

Technische Regeln für Druckbehälter (TRB):

TRB 100 *Werkstoffe* (Materials)

TRB 200 *Herstellung von Druckbehältern* (Fabrication of pressure vessels)

TRB 300 *Berechnung* (Design)

TRB 401 *Ausrüstung für Druckbehälter; Kennzeichnung* (Equipment for pressure vessels; marking)

TRB 402 *Ausrüstung für Druckbehälter; Öffnungen und Verschlüsse* (Equipment for pressure vessels; openings and closures)

TRB 403 *Ausrüstung für Druckbehälter; Einrichtungen zum Erkennen und Begrenzen von Druck und Temperatur* (Equipment for pressure vessels; devices for detecting and limiting pressure and temperature)

TRB 404 *Ausrüstung für Druckbehälter; Ausrüstungsteile* (Equipment for pressure vessels; components)

TRB 700 *Betrieb von Druckbehältern* (Operation of pressure vessels)

TRB 801 *Besondere Druckbehälter nach Anhang II zu § 12 Druckbehälterverordnung* (Special-purpose pressure vessels as covered in appendix II to § 12 of the *Druckbehälterverordnung*)

Technische Regeln für Dampfkessel (Codes of practice for steam boilers) (TRD):

TRD 413 *Kohlenstaubfeuerungen an Dampfkesseln* (Pulverized coal firing of steam boilers)

TRD 414 *Holzfeuerungen an Dampfkesseln* (Wood firing of steam boilers)

Merkblatt ZH 1/201 *Sicherheitsregeln für die Ausrüstung von Arbeitsstätten mit Feuerlöschern* (Rules for the furnishing of workplaces with fire extinguishers)

VDI-Richtlinie 3033 *Wärmeübertragungsanlagen mit anderen Wärmeträgern als Wasser; Aufbau, Betrieb und Instandhaltung* (Heat transfer systems operating with heating media other than water; construction, operation and maintenance)

Wasserhaushaltsgesetz (German Water Management Act)

Druckbehälterverordnung (Pressure Vessels Regulation)

Musterfeuerungsverordnung

Verordnung über genehmigungsbedürftige Anlagen

Richtlinie für die Aufstellung von Feuerstätten mit einer Gesamtwärmeleistung von mehr als 50 kW in anderen Räumen als Heizräumen (Code of practice for the installation of furnaces with a total nominal thermal output of more than 50 kW in rooms other than heating rooms)

Previous editions

DIN 4754: 10.74, 01.80.

Amendments

In comparison with its January 1980 edition, the standard has been completely revised (cf. Explanatory notes).

Literature

[1] *VDI-Wärmeatlas* (VDI Heat Atlas), 5th ed., 1988, *VDI-Verlag*, Düsseldorf.

[2] Wagner, W. *Wärmeträgertechnik mit organischen Medien* (Heating medium technology with organic media), 4th ed., 1986, *Technischer Verlag Resch KG*, Gräfelfing.

Explanatory notes

Legal provisions

The heat transfer systems operating with an organic heating medium dealt with in this standard are doubtless to be considered pressure vessels in the wider sense of the term, even if the installation of switch circuits or other measures will prevent the medium being heated to above its boiling point at atmospheric pressure.

This fact was duly taken into account in the preparation of the standard. The main technical requirements specified in the standard will also be found in the Appendix to the *Druckbehälterverordnung* in its version as amended on 1 May 1989. The previous edition of this standard was already approved by the building inspectorates, so that the standard is now binding on both the industrial and non-industrial sectors. In addition, the standard has also met with approval in neighbouring countries. The design of heat transfer systems in terms of heating technology as specified in this standard in no way renders dispensable the design of the system under the aspect of its mechanical strength, for which the specifications given in the *AD-Merkblätter* of the B series apply.

Re Foreword

Owing to the high operating temperature of heating media it was considered necessary to include an introductory remark to the effect that special competence is required from the contractors involved in the design and installation of such systems.

Re clause 1

For specific reasons, attention must here be drawn to the fact that in the preparation of this standard consideration was primarily given to the most common types of heat transfer systems with proven performance records. Certain concessions are made with respect to smaller systems. Thus, electrically heated heaters are to be manufactured for a working pressure of 2 bar, unless for operational reasons they are to be designed to withstand higher pressures.

Systems with a heating medium filling volume of less than 1000 l no longer need to be equipped with a receiver vessel.

Deviations from the specifications of this standard are permitted if proof is provided (e.g. by materials tests, experiments, stress analyses, or experience in the operation of a given system) that the level of safety implicit in the standard has been realized by other means.

In the preparation of the standard, the requirements specified by the *Wasserhaushaltsgesetz* were also taken into account.

Re subclause 3.2.1

Subclause 3.2.1 includes information on design pressures for various system components.

The following is to be noted in this respect.

1. Fuel-fired heaters are to be manufactured for a working pressure of 10 bar. This working pressure is also to be indicated by the manufacturers of the heaters on the nameplate. A number of systems are, however, operated at a lower pressure (pump head plus geodetic head). The expert who is responsible for inspecting the given system can determine the highest working pressure for the heater under the physical parameters preventing excess pressure, and have this pressure entered on the heater nameplate instead of the working pressure of 10 bar.

   Safety devices and the pressure to be applied in testing the system for tightness as specified in TRB 801 are to be selected as a function of the system pressure. The respective components are to be tested in the routine inspection with the same pressures as were applied in the initial inspection. Due attention shall be given to the suitability of the safety devices. The test may be conducted using the medium that is intended to be used in the system.

   The significant values in the determination of the pressure-litre product for the heater and for the other pressure vessels within a heat transfer system are the actual working pressures resulting from the pressure relief devices installed.

2. Sufficiently large vessels, such as expansion vessels and drain tanks that have an open connection to atmosphere are not pressure vessels within the meaning of the *Druckbehälterverordnung*. However, the responsible committee was of the opinion that certain minimum requirements should be specified for these components in order to ensure suitable design and adequate safety in service. Such vessels are then to be designed and manufactured in accordance with the provisions of the *Druckbehälterverordnung*. Accordingly, in subclause 3.2.1, a pressure of 2 bar was also specified for these vessels. Items of equipment which would be required for pressure vessels of similar size and working pressure, such as inspection glasses, are, however, not required. They shall be equipped with a nameplate on which as permissible working pressure the figure 0 or 'atm.' (for atmosphere) may be indicated. The manufacturer is then responsible for providing proof that the vessels are of adequate size. The reference to the 'open connection to atmosphere' is recommended. In such cases, the obligation to have an initial inspection and routine inspections carried out by an expert does not apply.

Re subclause 3.2.3

As absolute tightness of pipework cannot be guaranteed, the concept 'leakproof' was selected, the concept being defined as a condition under which the system, system components and accessories including all joints are at least so tight that there is at no point any risk of fire or explosion.

The concept includes non-hazardous leakages that are unavoidable for technical reasons, such as result from diffusion processes or that are inherent in the system. Such leakages cannot be precluded in the case of certain system components (e.g. pumps or valves) after long service, as these, owing to their construction, include selas which are subject to dynamic stresses. Such leakages can, however, be reduced to safe levels by proper maintenance or by installing special items of equipment.

The constant presence of an operator, or constant monitoring, required in subclause 3.3.3 can also be effected by way of a remote monitoring facility.

Re subclause 3.2.5

The insulation of heat transfer systems presupposes great expertise and experience. A detailed treatment of the subject would go beyond the scope of the present standard (see in this respect [2]).

Re subclauses 3.2.8.1 and 3.2.8.5

Supplementary to subclause 3.2.8.1, it should be noted that proposals were received from various parties to cover in this standard the design of systems with low-level expansion vessels, to reflect actual heating engineering practice.

In the case of large-scale heat transfer systems operating with organic fluids, however, safety problems are encountered (e.g. with regard to degasifying). The responsible committee thus considered it inexpedient to include designs of this type in this standard at this stage. The committee would welcome receiving specimen designs and reports on experience gained in the operation of systems with this type of vessel.