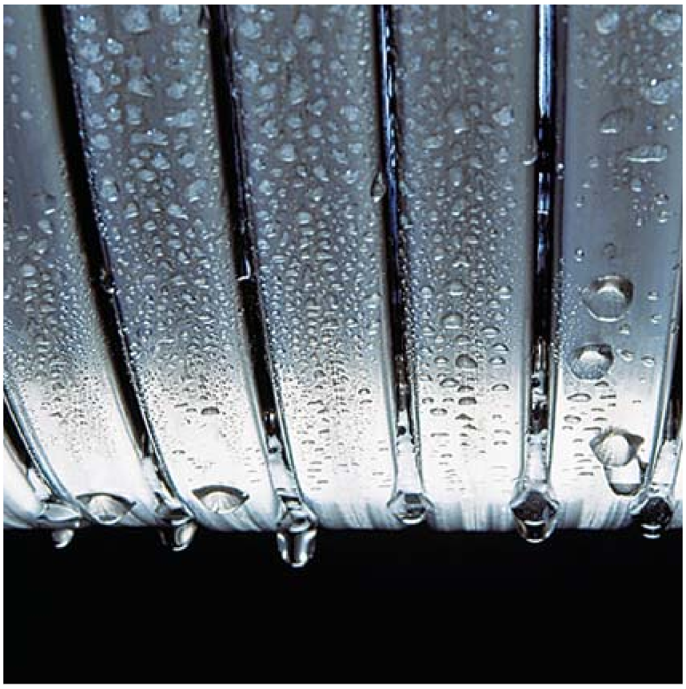
Technical Series

Condensing Technology

Condensing technology for improved economy and lower emissions



Whether gas or oil fired, freestanding or wall mounted – Viessmann offers a comprehensive selection of condensing boilers from 4.5 to 6600 kW

1 Vitodens 300
Gas fired wall mounted condensing boiler

2 Vitolaplus 300
Oil fired Unit condensing boiler

3 Vitodens 333
Gas fired condensing boiler with integral DHW loading cylinder

4 Vitocrossal 300
Gas fired condensing boiler

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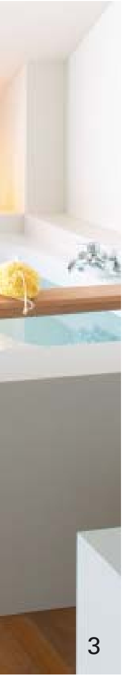


5 Vitocrossal 300
Gas fired condensing boiler

6 Vitodens 300
Gas fired wall mounted condensing boiler

7 Vitoplex 300
Low temperature oil fired boiler with Vitotrans 333 flue gas/water heat exchanger

8 Vitotrans 333
Flue gas/water heat exchanger

Condensing technology provides an efficient method of converting natural gas or fuel oil into useful energy by combustion (Fig. 1). As with low temperature technology, it follows the principle of operating the boiler only with that temperature which is required to cover the current heating demand.

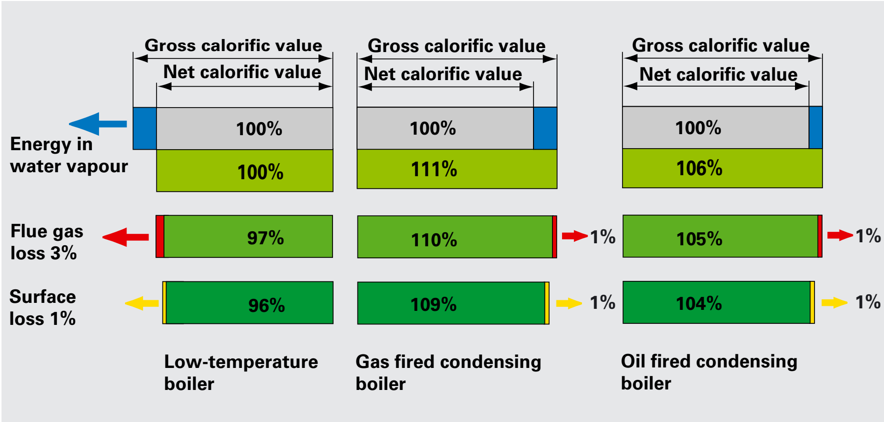


Fig. 1: Comparison of the losses for low-temperature and condensing boilers (natural gas, fuel oil EL)

Utilisation of latent heat

Whilst with low temperature boilers, the condensing of hot gases and subsequent wetting of the heating surfaces must be avoided, condensing technology operates to quite different rules: here, condensing hot gases is actually highly desirable and is needed to turn the latent (hidden) energy contained in water vapour, in addition to the sensible (tangible) flue gas energy, into useful heat. Also, the residual heat exhausted via the flue will be substantially reduced, since, compared to low temperature boilers, the flue gas temperature can be substantially reduced (Fig. 2).

Through the reaction with the air component (O_2), the combustion of fuel oil or natural gas, both of which primarily consist of carbon (C) and hydrogen (H) compounds, creates carbon dioxide (CO_2) and water (H_2O) (Fig. 3).

For natural gas (methane CH_4), the following simplified combustion equation applies:

$CH_4 + 2\,O_2 \rightarrow 2\,H_2O + CO_2 + \text{heat}$

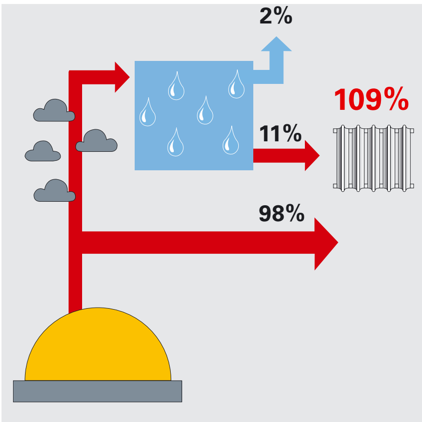


Fig. 2: Condensing boilers achieve a standard efficiency of up to 109% by gaining additional energy from flue gas (natural gas)

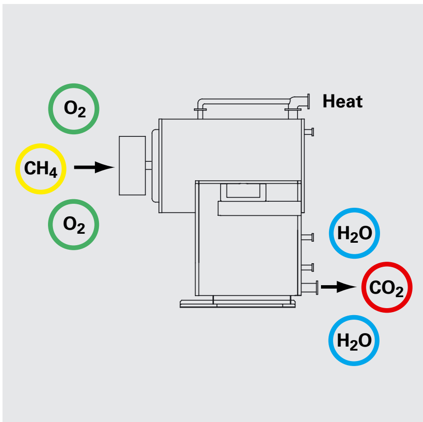


Fig. 3: Energy gain from hot gases (natural gas)

Gaining energy from condensation

Condensate will be formed from the water vapour contained in the hot gas, if the temperature on the walls of the heating surfaces on the hot gas side falls below the water vapour dew point.

The various chemical consistencies of natural gas and fuel oil result in different water vapour temperatures, at which the hot gas water vapour condenses. In the near stoichiometric range, the water vapour dew point for natural gas is approx. 57 °C, for fuel oil EL approx. 47 °C (Fig. 4).

The theoretical energy gain for natural gas, compared to low temperature technology, is 11%. With fuel oil, the maximum gain through the use of condensing technology is 6%.

Net and gross calorific value

The net calorific value (H_i) describes the energy released during complete combustion, if the water created in the process is removed as vapour.

The gross calorific value (H_s) defines the energy released during complete combustion including the evaporation energy contained within the hot gas water vapour. Table 1 provides an overview of the fuel characteristics which are relevant to the utilisation of condensing technology.

In the past, the evaporation energy could not be utilised because the relevant technical prerequisites were not yet available. Therefore, the net calorific value (H_i) was used as reference for all efficiency calculations. Referring to H_i and utilising the additional evaporation heat can thus lead to standard efficiencies above 100%.

Because of guidelines, standard efficiencies in heating technology continue to refer to the net calorific value (H_i).

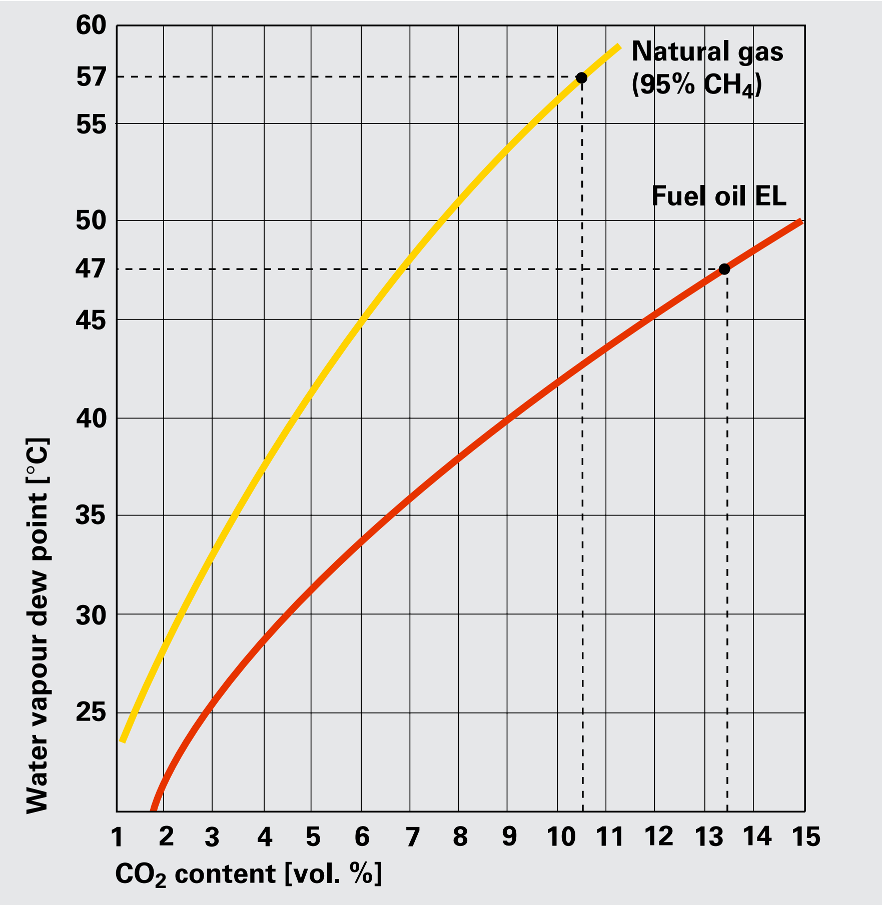


Fig. 4: Water vapour dew point temperature

	Gross cal. value H_s kWh/m³	Net cal. value H_i kWh/m³	H_s/H_i	$H_s - H_i$ kWh/m³	Condensate volume (theoretical) kg/m³ 1)
Town gas	5.48	4.87	1.13	0.61	0.89
Natural gas LL	9.78	8.83	1.11	0.95	1.53
Natural gas E	11.46	10.35	1.11	1.11	1.63
Propane	28.02	25.80	1.09	2.22	3.37
Fuel oil EL 2)	10.68	10.08	1.06	0.60	0.88

1) relative to the fuel volume
2) for fuel oil EL, details refer to the unit "litre"

Table 1: Energy content of different fuels

2 Significant variables for the utilisation of condensing technology

The energy advantage between a condensing boiler and a low temperature boiler is not just the result of the condensing energy gain, but is, to a large extent, a consequence of the low flue gas loss resulting from low flue gas temperatures.

A basic energy assessment can be made using the boiler efficiency.

2.1 Efficiency η_K of condensing boilers

Sensible | Latent (condensation part)

$$\eta_K = 1 - \frac{q_A - q_S}{100} + \frac{H_s - H_i}{H_i} \cdot \alpha$$

$$q_A = (\vartheta_A - \vartheta_L) \cdot \left(\frac{A_1}{CO_2} + B \right)$$

Significant variables

ϑ_A -> Flue gas temperature for condensing boilers: unlimited

CO_2 -> CO_2 concentration: combustion quality subject to burner design

α -> Condensate value subject to boiler design and system (layout)

$$\alpha = \frac{\dot{V}_{\text{Condensate volume (actual)}}}{\dot{V}_{\text{Condensate volume (theor.)}}}$$

(see Table 1)

Key

η_K = boiler efficiency [%]
ϑ_A = flue gas temperature [°C]
ϑ_L = air temperature [°C]
A_1 = fuel correction factor according to 1st BImSchV
B = fuel correction factor according to 1st BImSchV
CO_2 = carbon dioxide content [%]
q_A = flue gas loss [%]
q_S = radiation loss [%]
α = condensate value
H_s = gross calorific value
H_i = net calorific value

Compared with a conventional boiler, the boiler efficiency formula is extended by the condensation part. The condensation part is defined by the fuel-specific constant values H_s and H_i, as well as the variable condensate value α. It provides the ratio between the actual volume of condensate in a condensing boiler and the theoretically possible volume of condensate.

The higher the actual volume of condensate, the more effective the condensing boiler.

The lower the flue gas temperature, the greater the volume of condensate and therefore the condensate value α. At the same time, the lower flue gas temperature, for example compared to a low temperature boiler, also reduces the flue gas loss. This means that condensing boilers (Fig. 5) achieve a further improved energy utilisation through lowering the flue gas losses, as well as gaining condensation energy.

Fig. 5: Vitodens 300 gas fired wall mounted condensing boiler with Inox-Radial heating surfaces and MatriX-compact burner, rated output: 4.5 to 35.0 kW

	Fuel oil EL	Nat. gas	Town gas	Coking gas	LPG and LPG-air mixtures
A_1	0.5	0.37	0.35	0.29	0.42
A_2	0.68	0.66	0.63	0.60	0.63
B	0.007	0.009	0.011	0.011	0.008

Table 2: Fuel correction value acc. to the 1st BImSchV

2.2 Standard efficiency

The standard efficiency defined in DIN 4702, pt. 8, is used to calculate the energy efficiency of modern boilers. It is defined as the ratio between the heat available p.a. and the combustion heat supplied to the boiler (relative to the net calorific value of the fuel). A process was determined by DIN 4702, pt. 8, which will lead to comparable details based on standardised teststand measurements.
For Germany, five work load levels were determined relative to the defined annual heating output; these are illustrated in Fig. 6. The same heating output (area) is calculated for each load stage. Two temperature pairs result for each of the five levels defined by DIN 4702, pt. 8, (one pair based on radiator central heating: design basis 75/60 °C; one pair based on an underfloor heating system: design basis 40/30 °C to EN 677).
For each, a part-load efficiency is determined on the teststand.

To calculate the standard efficiency, the five actual part-load efficiency levels are averaged out. This results in comparable values, which generally reflect a realistic boiler operation in Germany.

Sizing the rated output

The boiler design should ensure that at the lowest likely outside temperature, the heat demand can be fully covered. For Germany, these design temperatures are -10 to -16 °C. However, such low temperatures are only rarely reached during average daytime operation, hence the boiler must only provide its full output for a few days each year. For the rest of the time, only a fraction of its rated output is required. Looking at a year as a whole, the greatest part of the required heating energy, therefore, relates to temperatures above freezing (0 to 5 °C) (Fig. 7).

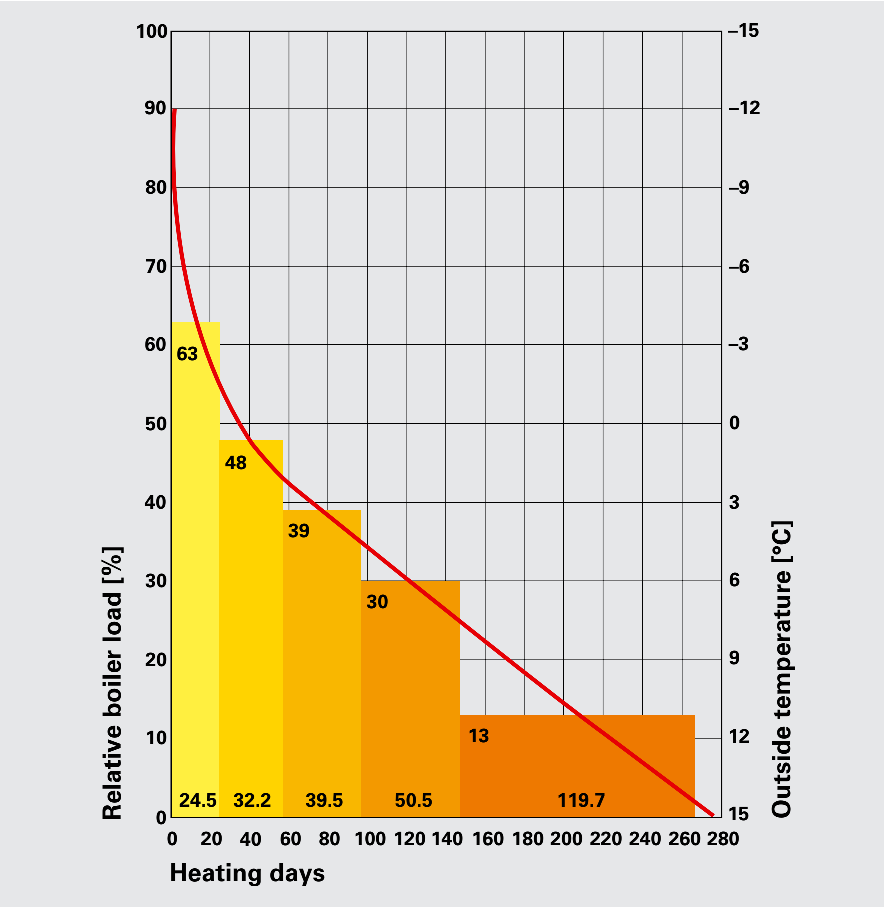


Fig. 6: Calculating the standard efficiency acc. to DIN 4702, pt.8

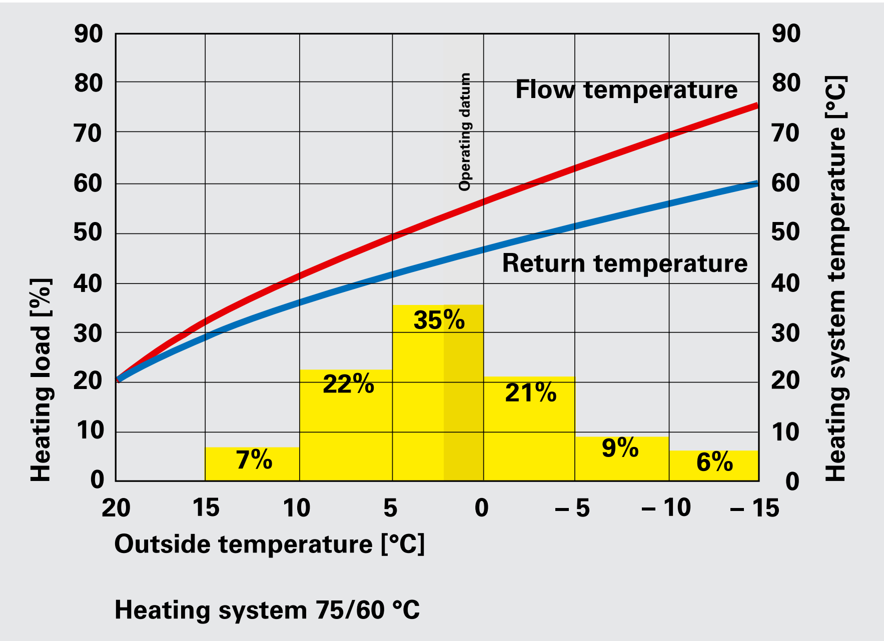


Fig. 7: Proportion of heating load subject to outside temperature

Significant variables for the utilisation of condensing technology

This results in the average boiler load over a period of twelve months, being less than 30% of rated output. Fig. 8 shows a comparison of part-load levels, particularly for low average loads.

Advantages of condensing technology

The advantages offered by condensing technology are particularly obvious at low load levels: boilers operating at a constant temperature suffer substantial losses with reducing load levels, since the boiler temperature must be maintained at a high level, even if the heating system temperature only demands a low output. One result is a substantially higher proportion of radiation loss as part of the overall energy requirement, hence reduced efficiency.

Condensing boilers, on the other hand, provide an especially high level of efficiency at low load levels, because the condensing effect is particularly successful due to the low temperature of the heating water.

Fig. 9 demonstrates a comparison of the efficiency levels for various types of boiler.

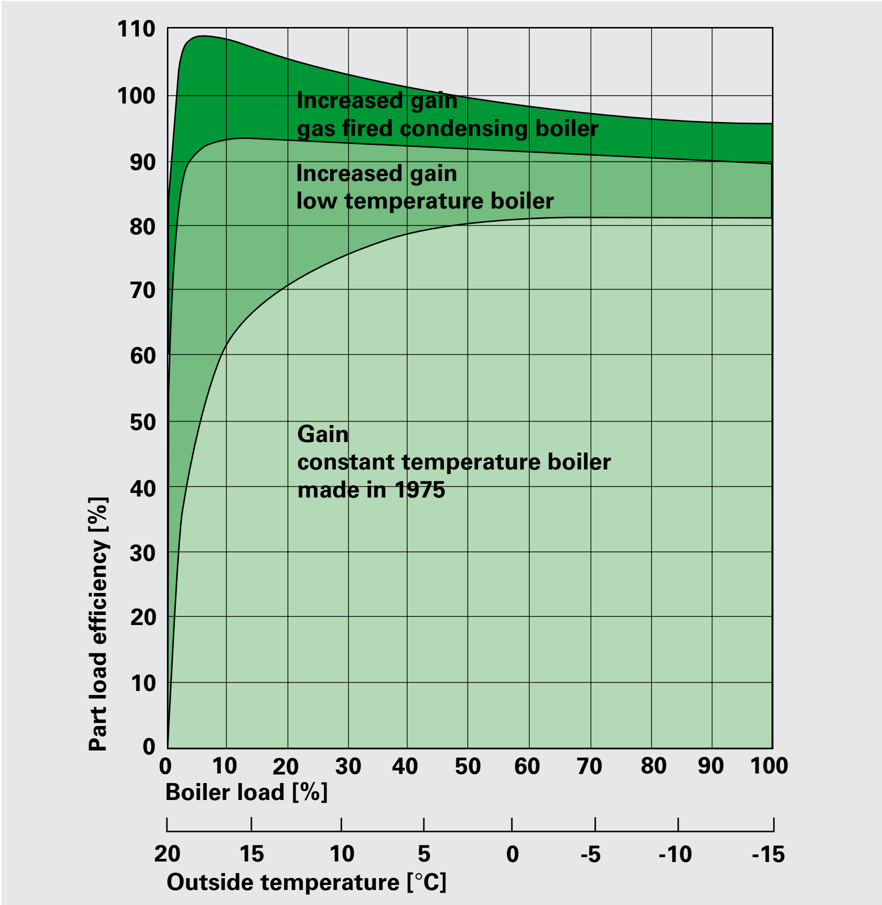


Fig. 8: Part-load efficiency levels for various boilers, subject to boiler load for low temperature and condensing boilers

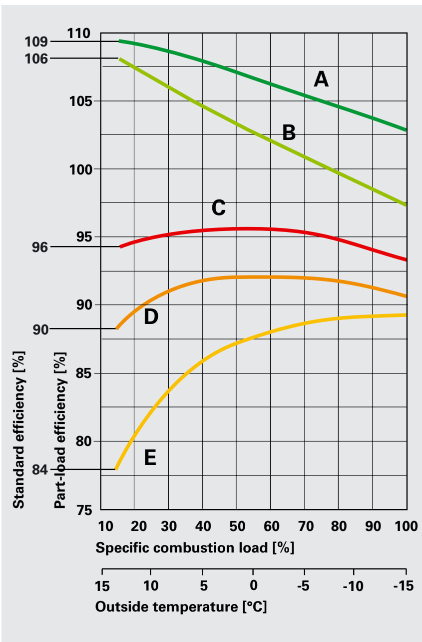


Fig. 9: Standard efficiency levels for various boiler designs

A Gas fired condensing boilers 40/30°C
B Gas fired condensing boilers 75/60 °C
C Low temperature boiler (without lower temperature limit)
D Boiler made in 1987 (lower temperature limit: 40 °C)
E Boiler made in 1975 (constant boiler water temperature: 75 °C)

3 Condensing technology in existing buildings

Condensation energy can be utilised not only with reduced load levels, i.e. low heating system temperatures. Even with heating systems designed for 75/60 °C, the actual temperature in the return falls below the dew point when operating at load levels in excess of 90% or outside temperatures as low as -11.5 °C, so that hot gas water vapour can condense. This enables the system to function inside the condensing range for more than 90% of its operation, even with a high design temperature of 75/60 °C as shown in Fig.10. Even better are the conditions for low temperature heating systems such as underfloor heating (40/30 °C), where condensing operation is achieved all the year round.

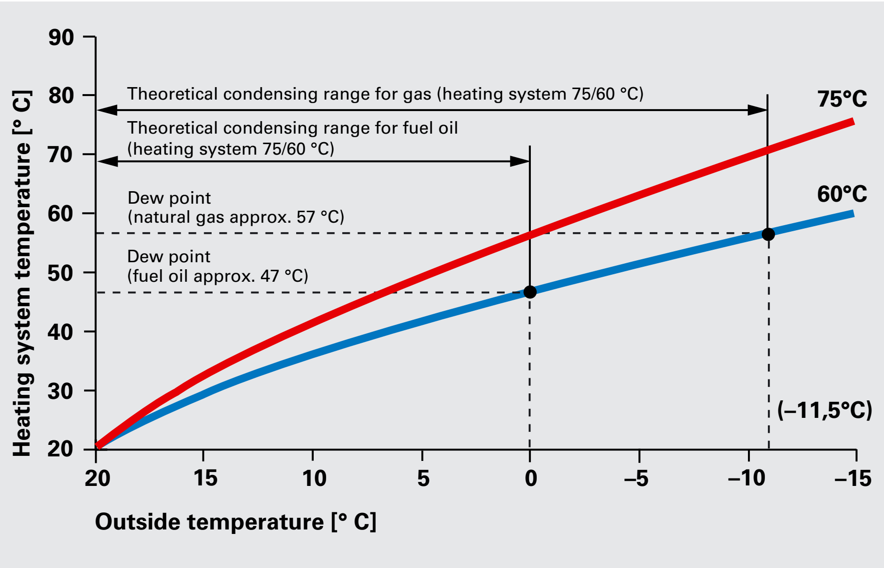


Fig. 10: Flow/return temperature, subject to outside temperature, condensing gain

Oversized older systems allow a reduction in temperature

Experience shows that older buildings are frequently equipped with oversized radiators. This oversizing is partly due to an over-generous design during initial installation and also to subsequent thermal insulation measures: retrofitted doubled glazed windows, cladding and roof insulation substantially reduce the heating demand, whilst the original radiator size remains unchanged. This enables the flow and return temperatures to be significantly reduced from their original design (e.g. 90/70 °C).

How much a system, originally designed for 90/70 °C, needs to be reduced or exactly how oversized it is, can be estimated in situ: for this, a simple test is carried out and assessed using Fig. 12.

Fig. 11: Vitocrossal 300 gas fired condensing boiler with Inox-Crossal heating surfaces and MatriX-compact gas burner, up to 66 kW

Condensing technology in existing buildings

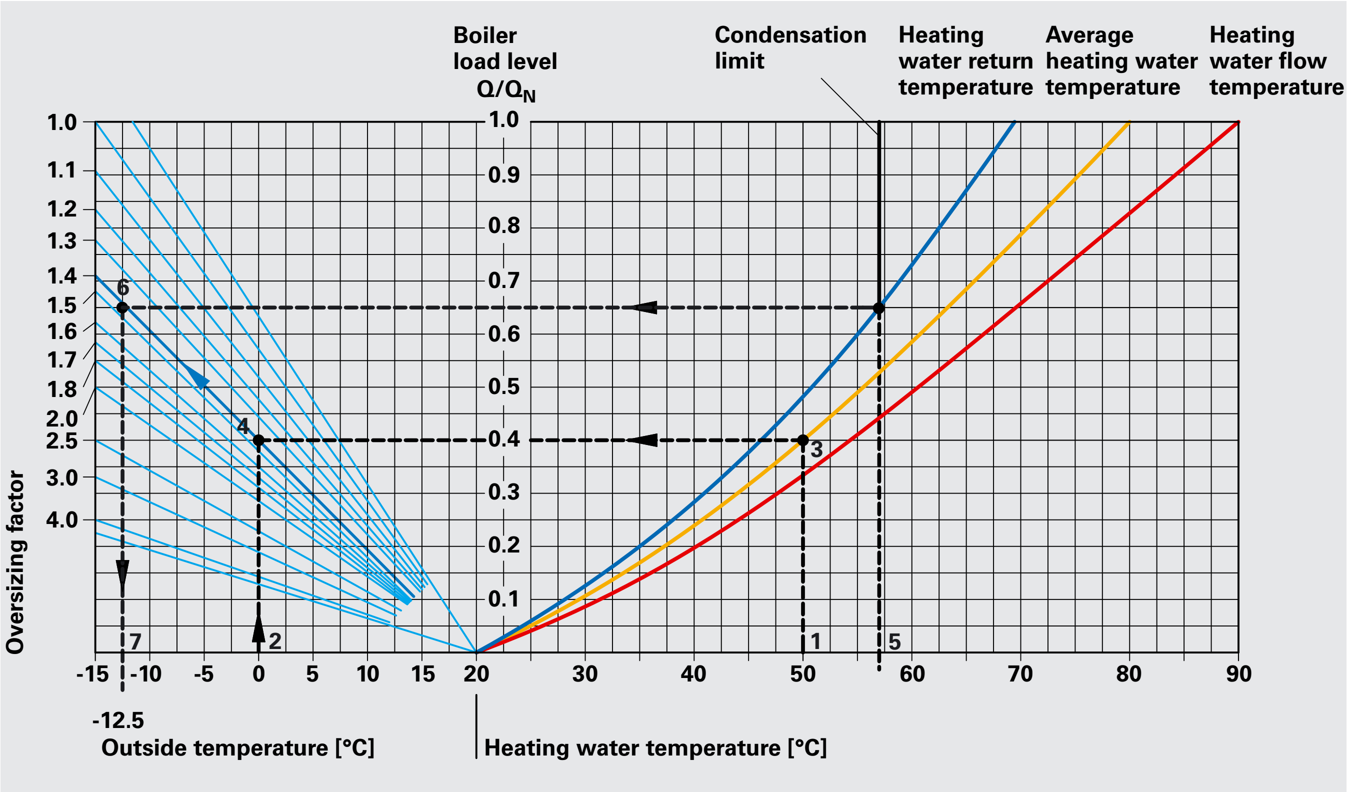


Fig. 12: Calculating the oversizing of the heating surfaces (system 90/70 °C)

In winter, and at cold outside temperatures, open all radiator valves in the evening and read off the flow and return temperatures the following afternoon. Preconditions are that the boiler and mixer are set so that room temperatures reach the desired range (20 to 23 °C) when the radiator valves are fully opened.

The average value, comprising the flow and return temperatures (mean heating water temperature, e.g. (54 + 46) / 2 = 50 °C) is the input size (1) for the diagram. At the same time, the current outside temperature should be known (in this example: 0 °C) (2).

Bringing the vertical of (1) with the curve of the average heating water temperature to the intersection results in (3). Proceeding horizontally from (3) to the intersection with the vertical of (2), the so-called oversizing factor (6) results at the intersection with the outside temperature (4) (in this example 1.4). In other words, the heating surfaces are 40% oversized. This means that with the lowest expected outside temperature (e.g. -15 °C), the average heating water temperature would not have to be 80 °C, as intended, but only 65 °C.

The condensation limit for hot gases created by the combustion of natural gas is approx. 57 °C (5). The return temperature must fall below this value to achieve partial condensation of the hot gases and thereby to achieve the condensing benefit.

In the example shown, which indicates oversizing by a factor of 1.4 (6), the actual temperature falls below this return temperature at outside temperatures as low as -12.5 °C (7).

The utilisation of condensing technology in the illustrated example will not be fully achieved/not achieved at all only on days where the outside temperature falls below -12.5 °C. However, on such days, a condensing boiler will still be more efficient than a low temperature boiler because of its substantially lower flue gas temperatures.

4 Significant variables and criteria for optimum gain

4.1 Boiler design

Utilisation of condensing technology improves with increasing condensation of the hot gas water vapour. Only this enables the latent energy in hot gas to be converted into useable heating energy. Conventional boiler designs are unsuitable for this task, see Fig.13.

Flow paths

In conventional low temperature boilers, the heating surfaces are designed to prevent condensation of hot gases inside the boiler. Condensing boiler design is quite different: the Inox-Crossal heating surface was designed so that hot gases and condensate flow in the same direction, i.e. down. This creates a permanent self-cleaning effect, which also prevents condensate concentrations.

Hot gas and heating water inside the heat exchanger should flow in a countercurrent pattern to utilise the low temperature of the return water influx, in order to provide maximum cooling of the outflowing hot gases. At the same time, modulating burners with suitably intelligent controls should be utilised, to enable automatic matching of the output to the current heating demand.

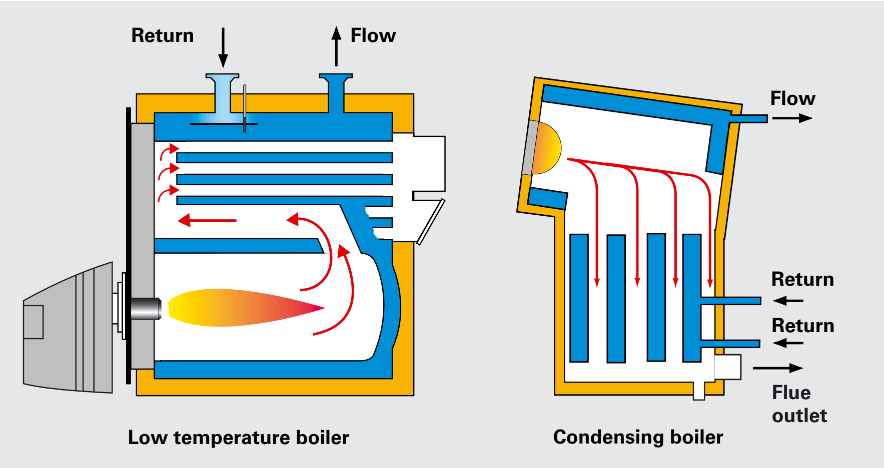


Fig. 13: Boiler design features

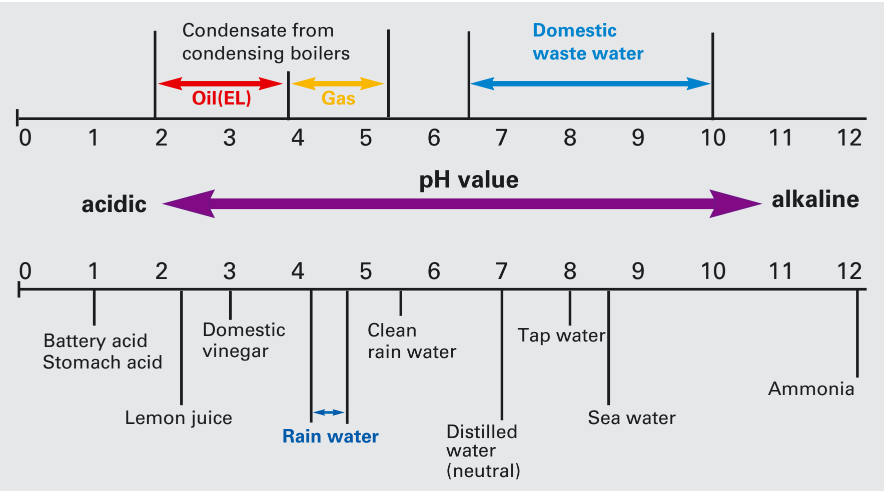


Fig. 14: pH value of different substances

Material and fuel

The selection of suitable materials should ensure that the condensate created will not cause the boiler to suffer corrosion damage. During combustion, constituents of the fuel (fuel oil or natural gas) and of the combustion air create compounds which shift the pH value (degrees of alkalinity or acidity) of the condensate up to acid levels (Fig. 14).

Carbon dioxide can form from the CO_2 created during combustion, and the nitrogen N_2 contained within the air reacts to become nitric acid. Using standard fuel oil for combustion can create particularly aggressive condensate, as the sulphur content of fuel oil creates sulphurous and sulphuric acid. Therefore, all heat exchanger surfaces which come into contact with condensate must be made from materials which remain unaffected by the chemical attack of the condensate constituents.

For some years now, stainless steel has proved to be the ideal material for this purpose. For fuel oil and natural gas, different stainless steel alloys are available (alloying elements are, amongst others, chromium, nickel, molybdenum, titanium), which have been matched to the characteristics of condensate. This enables these materials to withstand the corrosive attack of condensate without further treatment.

Significant variables and criteria for optimum gain

Hot gas paths

The use of stainless steel allows for an optimum geometric design of the heat exchanger surfaces.
To transfer the hot gas energy efficiently to the heating water, it is essential that hot gases are in intensive contact with the heating surface. To achieve this, two options are generally available:

The heating surfaces may be designed so that the hot gas is constantly swirled, avoiding the formation of core flows with higher temperatures (Fig. 15).
Smooth pipes are unsuitable for this purpose; instead deviations and changes in the cross-section must be created (Inox-Crossal heating surface).

An alternative to the intensively swirling hot gas flow achieved by the Inox-Crossal heating surface, is the laminar heat transfer method (Inox-Radial heating surface).

Inox-Crossal heating surface

Fig. 16 shows the Inox-Crossal heating surface, which offers excellent heat transfer properties. Deviations are achieved through opposing pressings. The changing cross-sections created by the constrictions reliably prevent the creation of core flows.

To prevent concentration of condensate and its return into the combustion chamber, hot gas and condensate should flow in the same direction, i.e. down. This allows condensate droplets to flow downward, supported by gravity and following hot gases. Therefore, the hot gas exit of heat exchangers is generally arranged at the bottom.

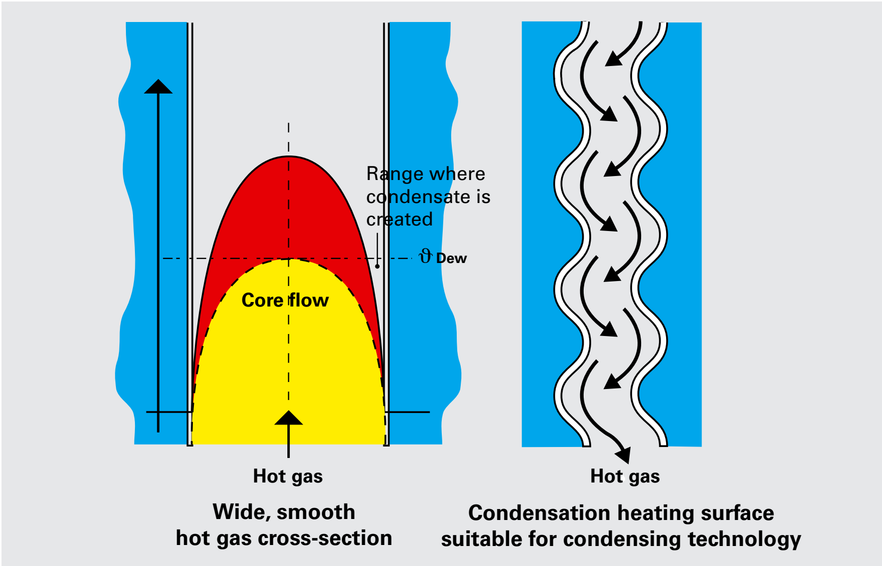


Fig. 15: Physical requirements for hot gas flues with a larger cross-section – Inox-Crossal heating surface

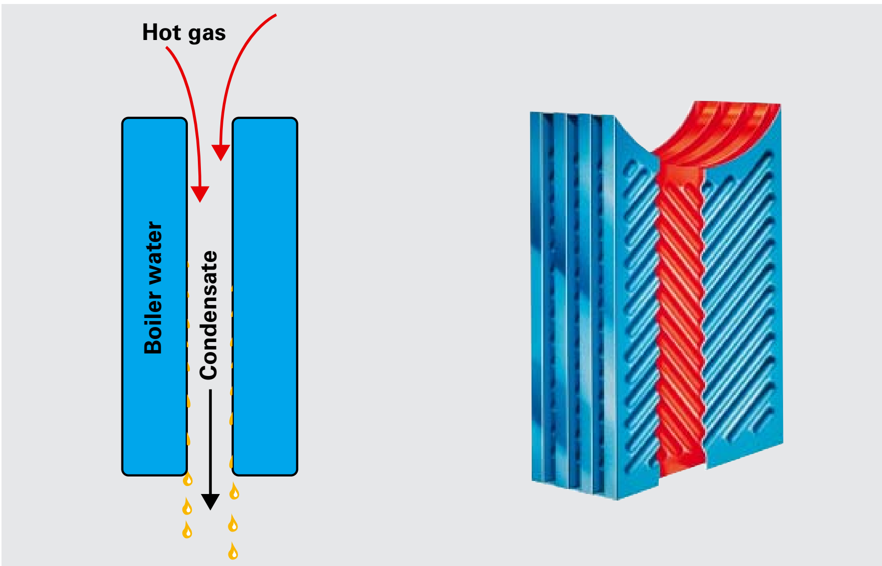


Fig. 16: Hot gas and condensate flow

Significant variables and criteria for optimum gain

Inox-Radial heating surface

The Inox-Radial heating surface (Fig. 17 & 18) was developed to achieve this laminar heat transfer principle; it comprises a stainless steel, spiral-shaped, rectangular hollow section. Special pressings create individual windings precisely 0.8 mm apart. These centres, which are matched to the special flow characteristics of hot gases, ensure that a laminar flow without a boundary layer is created inside the gap, which provides an excellent heat transfer. Over a gap length of only 36 mm, the hot gases can be cooled down from 900 °C (Fig. 19).

Under the most favourable conditions, the hot gas will reach a temperature level at the boiler outlet, which is only 3.5 K above the boiler water return temperature.

Fig. 17: Inox-Radial heating surface

Fig. 18: Inox-Radial heating surface

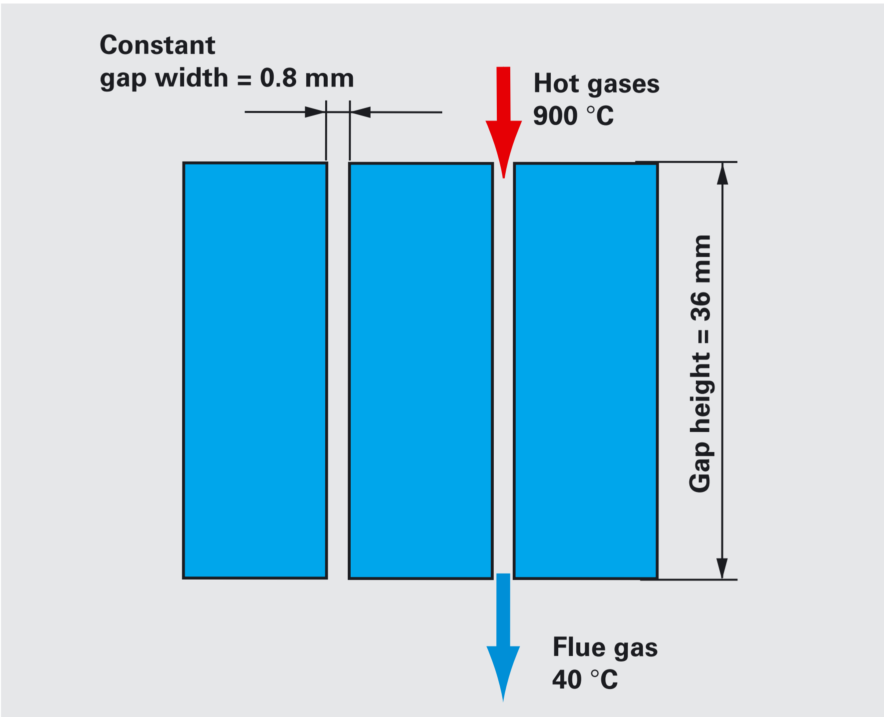


Fig. 19: Laminar heat transfer of the Inox-Radial heating surfaces: individual windings are 0.8 mm apart

4.2 Utilising oil fired condensing technology

Fuel oil, itself, has been the main obstacle for an early deployment of oil fired condensing systems in the past. According to DIN 51603-1, standard fuel oil EL can contain up to 2000 ppm sulphur, i.e. 2000 mg/kg. At such levels, combustion creates substantial quantities of sulphur oxide (SO_2 and SO_3). These form substantial quantities of sulphurous and sulphuric acid when the water vapour contained in hot gas condenses on the heating surface of the condensing boiler.

Now that fuel oil EL with a sulphur content of 50 ppm, which equates to 50 mg/kg, is generally available in Germany, the way is finally clear for oil fired condensing technology. The DIN committee on "Mineral oil and fuel standardisation" has settled on this new fuel oil quality and adopted it into DIN 51603-1. It was also important to ensure that this new fuel oil quality was adopted into the third ordinance regarding the implementation of the Federal Immissions Act (3rd BImSchV). This stipulates that fuel oil EL may only be described as "low sulphur", if it contains less than 50 ppm sulphur. In addition to standard fuel oil EL with a sulphur content of up to 2000 ppm and low sulphur oil, both of which are still available, "sulphur-reduced" fuel oil with up to 500 ppm sulphur is also available.

	Integral boiler heat exchanger	Downstream heat exchanger	Neutralising system
Standard fuel oil (≤ 2000 ppm)	Problematic high deposit levels	Permissible moderate deposit levels	Compulsory
Sulphur reduced fuel oil (≤ 500 ppm)	Permissible, moderate deposit levels	Permissible, low deposit levels	Compulsory
Low sulphur fuel oil (≤ 50 ppm)	Permissible, low deposits levels	Permissible, no deposits	Not required

Table 3: Framework conditions for condensing boilers with integral or downstream heat exchanger

Basically a distinction is drawn between two types of oil fired condensing systems (Table 3):

– Condensation on an integral boiler heat exchanger or on one installed downstream and heat transfer to the heating water

or

– Condensation inside the flue gas system and transfer of the energy to the ventilation air (preheating the air supply).

Heat exchanger inside the boiler or installed downstream

Oil fired condensing boilers are designed, so that the condensation energy is transferred directly to the heating water, either inside the boiler or inside a heat exchanger installed downstream of the boiler.

In systems only equipped with one heat exchanger, condensation energy is gained immediately inside the boiler. Such boilers correspond to the gas fired condensing boilers, which have been established for many years.

As an alternative, a separate heat exchanger for the utilisation of condensing technology, can also be installed downstream of the boiler. In such cases, the condensing boiler comprises of two heat exchangers: Inside the combustion chamber, the hot gas is cooled down by the first heat exchanger to temperatures above the dew point. The cooled hot gas then flows through a second heat exchanger, which is designed to condensate the hot gas. Both heat exchangers are connected to the heating circuit.

Significant variables and criteria for optimum gain

Heat exchangers inside the boiler, where condensation takes place, are subject not only to high flame temperatures but also to the unavoidable deposits which stem from the sulphur content of fuel oil. For this it is essential to design the heat exchanger for condensing, i.e. to use corrosion-resistant materials, such as stainless steel.

To reduce deposits, low sulphur (< 50 ppm) or sulphur-reduced (< 500 ppm) fuel oil EL should be used. This ensures a long service life, energetic quality and high efficiency, even if systems are cleaned only once a year. Also, in accordance with the new ATV Code of Practice [Germany], there is no longer any compulsion to employ a neutralising system when burning low sulphur fuel oil EL (< 50 ppm).

With downstream condensation heat exchangers, standard fuel oil can also be used (up to 2000 ppm), as combustion and condensation take place in physically separate locations. The resulting combustion residues, which also contain sulphur reaction products, are mainly deposited on the heat exchanger surfaces inside the combustion chamber. However, the matched temperature control inside the boiler prevents any condensation forming there. A practically deposit-free condensation process only takes place in the downstream heat exchanger.

It should be remembered, though, that condensate must be neutralised when using standard or sulphur-reduced fuel oil EL. This obligation is only waived for low sulphur fuel oil.

Fig. 20: Vitolaplus 300 oil fired Unit condensing boiler and Vitoplus 300 oil fired wall mounted condensing boiler

Preheating the air supply

This version of utilising oil fired condensing technology is based on the principle that condensation energy is not transferred directly to the heating water, but is used for heating the air supply. For this, heat exchanger and waterways inside the boiler are designed so, that the formation of condensate is prevented.

For that reason, flue gases entering the flue gas system are still at a temperature of approx. 100 °C. For systems like these, the flue gas/air supply system is designed as coaxial system, enabling the flue gas streaming downward to transfer its energy in a countercurrent to the inrushing air supply. The flue gas condensates, if the actual temperature drops below the dew point, making it possible to also transfer latent heat to the ventilation air and thereby achieve the gross calorific value.

The extent of achieving the gross calorific value with these systems is not only subject to the boiler, but also to the framework conditions of the flue gas/air supply system. It would therefore be appropriate to refer to condensing systems instead of condensing boilers.

Significant variables and criteria for optimum gain

Wall mounted oil fired condensing technology: Vitoplus 300

The Vitoplus 300 oil fired wall mounted condensing boiler (Fig. 21) is equipped with a stainless steel Inox-Radial heating surface designed specifically with oil fired condensing technology in mind. Together with the use of low sulphur fuel oil, this special material (1.4539) ensures reliable operation and a long service life.

Vitoplus 300 (Fig. 22) is based on the same modular design as the range of Vitotec gas fired wall mounted boilers.

The two stage Compact blue flame burner is characterised by its clean combustion and its reliable, environmentally responsible operation. When using low sulphur fuel oil, the flue gas sulphur content is comparable with that created by natural gas. This makes neutralising unnecessary.

Its practical usefulness is further enhanced by the ease with which it can be cleaned. The adjustable spiral of the Inox-Radial heating surface makes annual maintenance very easy – indeed it can be relaxed to provide an 8 mm cleaning gap –. This enables unavoidable combustion residues produced by fuel oil to be quickly and thoroughly removed. (Fig. 23).

Fig. 21: Oil fired wall mounted condensing boiler Vitoplus 300

Fig. 22: Vitoplus 300 with Vitocell-W 100

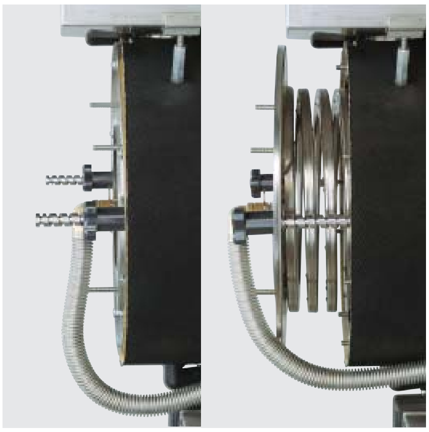


Fig. 23: Adjustable Inox-Radial spiral heat exchanger

Freestanding oil fired condensing boiler: Vitolaplus 300

Vitolaplus 300 (Fig. 24) is a freestanding oil fired condensing boiler with an attractive cost:benefit ratio. Apart from a high degree of operational reliability, particularly its compact design offers benefits, as Vitolaplus 300 can be installed even in the tightest of spaces. For the output range 19.4 to 29.2 kW, Vitolaplus 300 therefore offers an ideal solution for utilising oil fired condensing technology in modernisation projects.

Three components in the Vitolaplus 300 oil fired Unit condensing boiler lead to our goal: The proven Vitola 200 with its biferral heating surface, together with the new clean combustion Vitoflame 300 blue flame burner (Fig. 25) and the downstream Inox-Radial heat exchanger result in this reliable, economical and environmentally responsible oil fired Unit condensing boiler.

Vitolaplus 300 is particularly suitable for modernising heating systems, as the wide water galleries inside the heat exchangers are less sensitive to contamination and sludge from older heating systems. The combination of the proven biferral composite heating surface inside the combustion chamber and the corrosion-resistant Inox-Radial heat exchanger in the condensation stage ensures high levels of reliability and a long service life (Fig. 26).

Vitolaplus 300 can be operated with all commercially available types of fuel oil. According to the [German] ATV-DVWK Code of Practice A 251, a neutralising system is superfluous when using low sulphur fuel oil (up to 50 ppm).

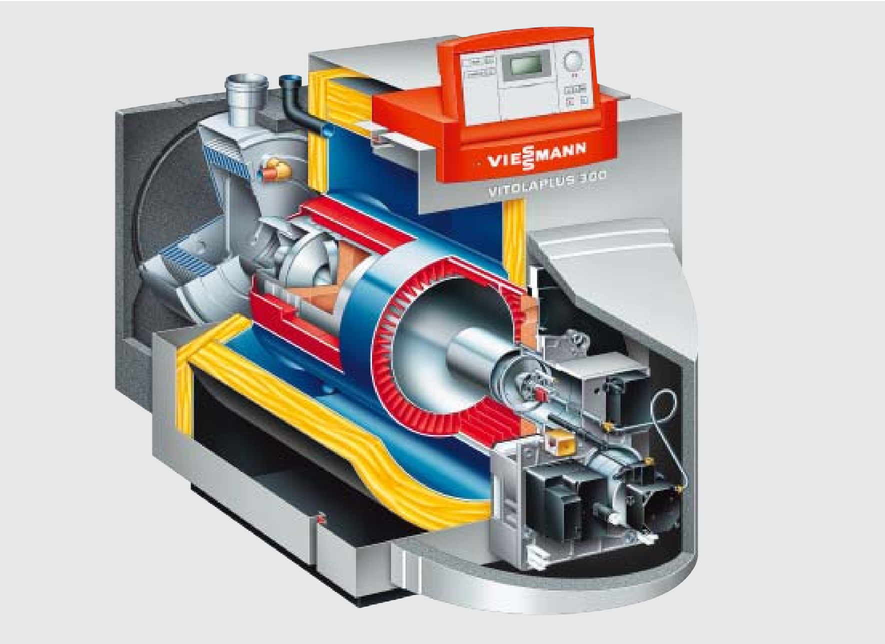


Fig. 24: Oil fired Unit condensing boiler Vitolaplus 300

Fig. 25: Vitoflame 300 in maintenance position

Fig. 26: Downstream Inox-Radial heat exchanger

Vitotrans 333 flue gas/water heat exchanger for condensing boilers up to 6600 kW

The Vitotrans 333 flue gas/water heat exchanger installed downstream of the boiler ensures, that condensing technology can also be used in medium and large boilers. Their use leads to a substantial reduction in operating costs (Fig. 27).

By installing a downstream Vitotrans 333 flue gas/water heat exchanger when using natural gas, the standard efficiency can increase by up to 12%, and when using fuel oil by up to 7%.

Vitotrans 333 is available in two versions for different output ranges. Up to 1750 kW, it is equipped with the Inox-Crossal heating surfaces (Fig. 28), and from 1860 to 6600 kW it is equipped with the Inox-Tubal heat exchanger pipes.

Both flue gas/water heat exchangers are highly efficient and are made from stainless steel. This prevents the risk of corrosion through acidic condensate. The countercurrent principle of flowing boiler water and hot gases in opposite directions creates a particularly high condensation rate. The vertical layout supports the self-cleaning effect: any condensate can drain off freely downward. In doing so, it flushes the heating surfaces and keeps them clean.

Fig. 27: Vitoplex 300 with downstream Vitotrans 333 flue gas/water heat exchanger

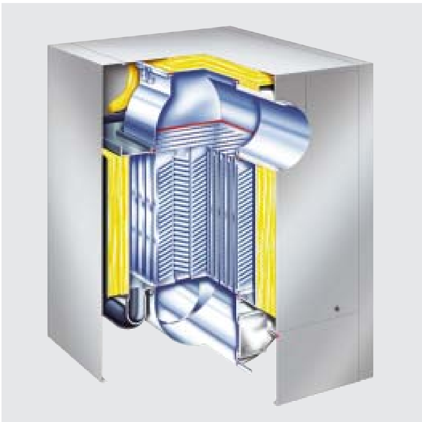


Fig. 28: Vitotrans 333 with Inox-Crossal heating surfaces for boilers from 80 to 500 kW

4.3 CO_2 content, burner design

For the efficient utilisation of condensing technology it is important, that combustion takes place with a low level of excess air or a high CO_2 content, since this influences the water vapour dew point (Fig. 29).

The water vapour dew point should be kept as high as possible, to allow condensation to be achieved even in heating systems with high return temperatures. Therefore, a high CO_2 content – in other words little excess air – in hot gas is desirable. The actual CO_2 content achieved depends primarily on the burner design.

For this reason, atmospheric burners should not be used, as these – due to their high level of excess air – tend to operate with low CO_2 values, which lead to low hot gas dew point temperatures. At flue gas temperatures of 50 °C or below, the thermal flue gas current is generally insufficient to ensure the function of the chimney or flue gas system by natural draught. In this context it is important that fans for modulating boilers are speed-controlled to enable the air volume to be matched to the gas volume flow. Only this way can the high CO_2 content be ensured in modulating operation, too.

For wall mounted gas fired condensing boilers, the power consumption of such fans amounts to approx. 50 kWh/p.a., leading to annual running costs of approx. € 6.

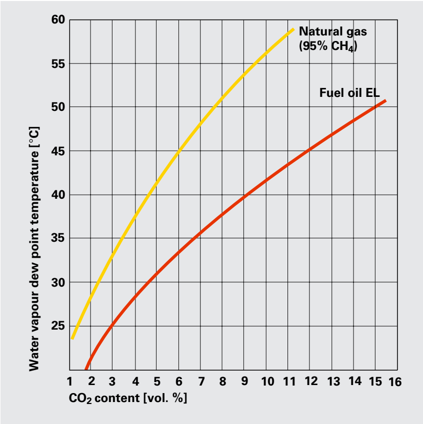


Fig. 29: Water vapour dew point subject to CO_2 content

Fig. 30: Modulating, pressure-jet MatriX-compact gas burner up to 66.0 kW

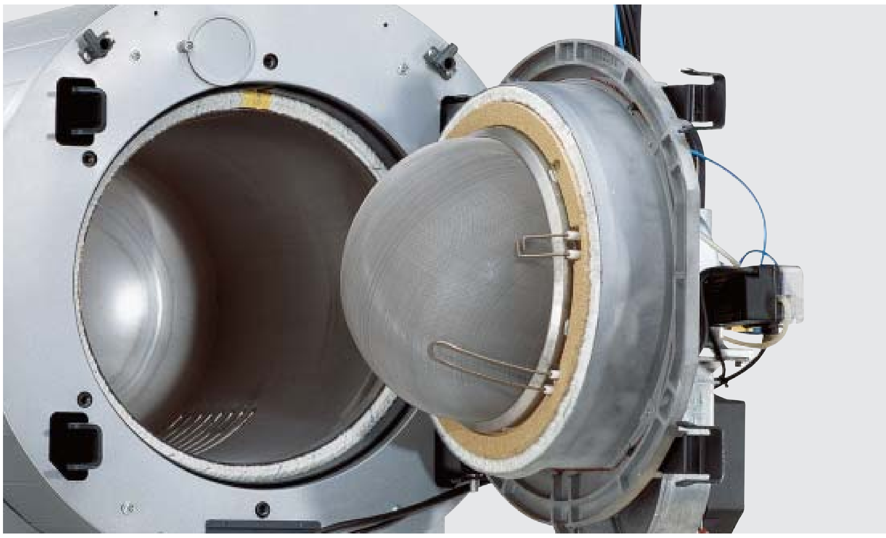


Fig. 31: MatriX radiant burner, rated output: 87 and 187 kW

4.4 Water connections

The design of the hydraulic system must ensure, that return temperatures significantly below the hot gas dew point are achieved, to ensure that the hot gas will condense.

One essential measure to achieve this is to avoid raising the return temperature by direct connection with the flow. For that reason, hydraulic systems using a four-way mixer should be avoided in condensing boiler systems. Instead, three-way mixers could be used. These channel the return water from the heating circuits directly to the condensing boiler, i.e. without raising the temperature (Fig. 32).

Also, thermostatic three-way valves should be avoided, since they cause the flow and return to be directly connected and will therefore raise the return temperature (Fig. 33).

Modulating circulation pumps automatically match their capacity to the system requirements, and thus prevent any unnecessary raising of the return temperature. This supports the utilisation of condensing technology.

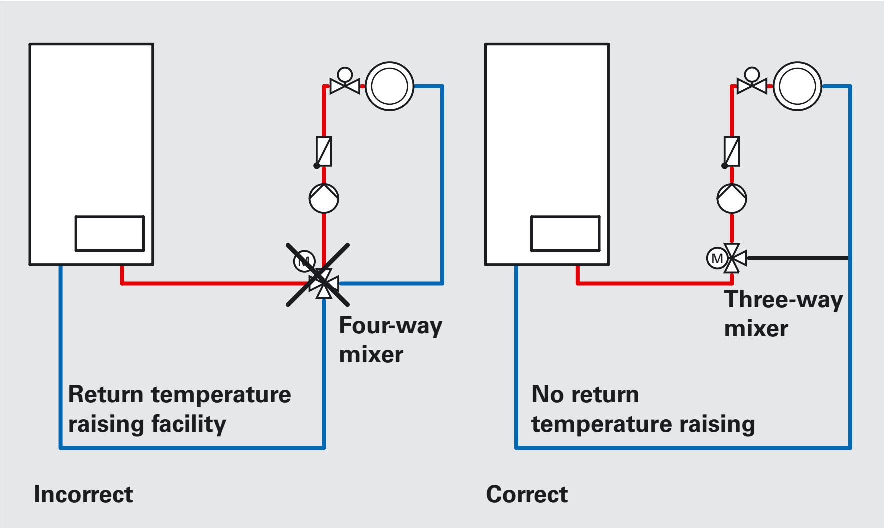


Fig. 32: Hydraulic requirements for condensing technology

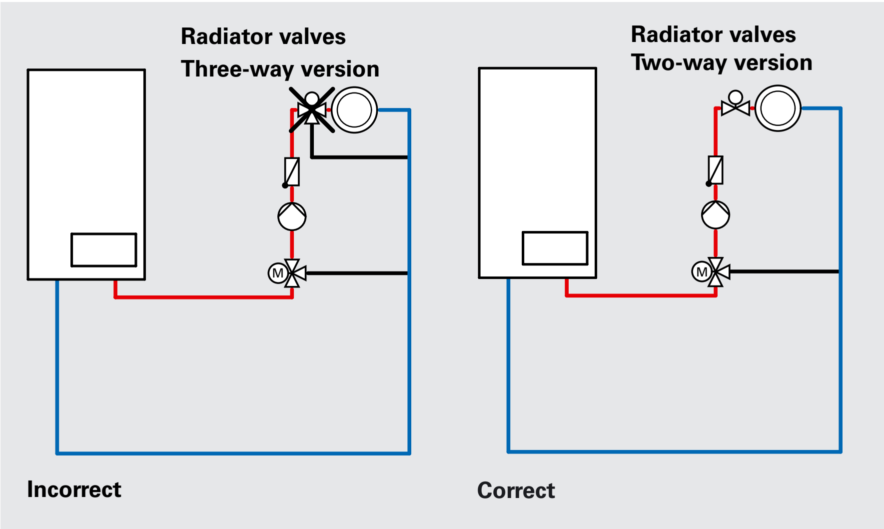


Fig. 33: Hydraulic requirements for condensing technology

Low loss header

In some cases, a distributor without differential pressure or a low loss header cannot be avoided (Fig. 34). Previously, low loss headers were used to ensure the presence of a minimum circulation volume inside the boiler. Modern condensing boilers no longer require this.

However, it may be the case that the maximum permissible boiler flow rate is less than the circulating volume inside the heating circuit, e.g. in underfloor heating systems. Here the higher heating circuit volume flow should be balanced with the boiler circuit volume flow via a low loss header. This avoids raising the return temperature.

The capacity of boiler circuit or heating circuit pumps must be selected, so that the higher volume flow is circulated in the heating circuit, to reliably prevent a mixing of warm flow water with the return. The flow temperature sensor must be installed downstream of the low loss header, to record the temperature, which is relevant to the system, after the colder return water has been mixed into the flow.
Careful design and adjustment are required, if the use of a low loss header cannot be avoided to achieve the best possible condensing effect.

Rules for designing with wall mounted boilers:

- A low loss header is generally required for cascades of several boilers.
- When balancing the low loss header, the volume flow on the boiler side should be adjusted approx. 10 to 30% lower than the volume flow on the system side (lower return temperature).
- The low loss header should be sized for the max. volume flow which may occur in the overall system.

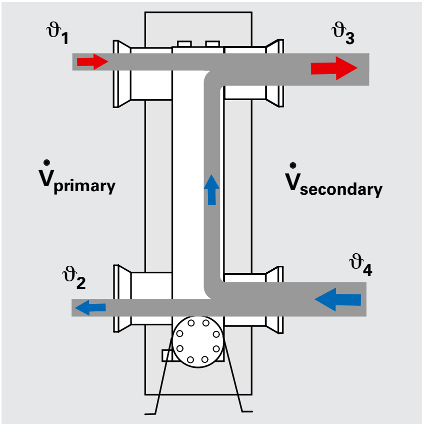


Fig. 34: Low loss header function

Key

$\dot{V}_{primary}$	heating water volume boiler circuit
$\dot{V}_{secondary}$	heating water volume heating circuit
ϑ_1	Flow temperature boiler circuit
ϑ_2	Return temperature boiler circuit
ϑ_3	Flow temperature heating circuit
ϑ_4	Return temperature heating circuit
$\dot{Q}_{primary}$	Heat volume supplied by the boiler
$\dot{Q}_{secondary}$	Heat volume dissipated by the heating circuit

$\dot{V}_{primary} < \dot{V}_{secondary}$
$\vartheta_1 > \vartheta_3$
$\vartheta_2 \approx \vartheta_4$
$\dot{Q}_{primary} = \dot{Q}_{secondary}$

Connection of DHW cylinders

Any DHW cylinder, which may be integrated into the system, should be connected upstream of the low loss header, since that is where the highest system temperatures occur thus enabling a reduction of the loading time.
Connection downstream of the low loss header would, if no mixer was installed, also lead to the unregulated heating of the heating circuits.

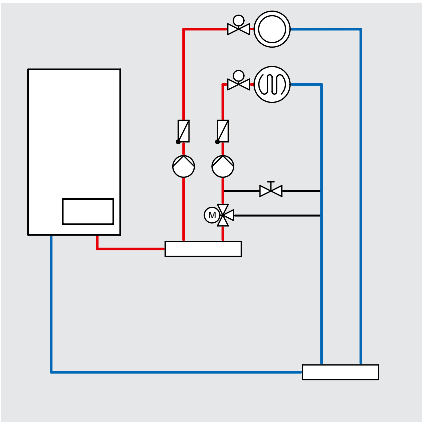


Fig. 35: Hydraulic requirements for condensing technology

The achievable gross calorific value is also influenced by the sizing of the pump capacity or spread. Fig. 35 illustrates this influence: halving, in an existing system ($\dot{Q}$ = const.), the capacity (V) increases the spread ($\Delta\vartheta$). However, the average radiator temperature will initially drop.

$\dot{V} = \dot{Q} / \Delta\vartheta$

If the flow is raised so that, when heat is transferred to the room, the original temperature conditions are reinstated, the spread doubles if the average temperature is identical; the return temperature drops correspondingly. This significantly improves the condensing effect.
In reverse it follows that high capacities reduce the spread and can therefore potentially reduce the condensing effect (Fig. 36).

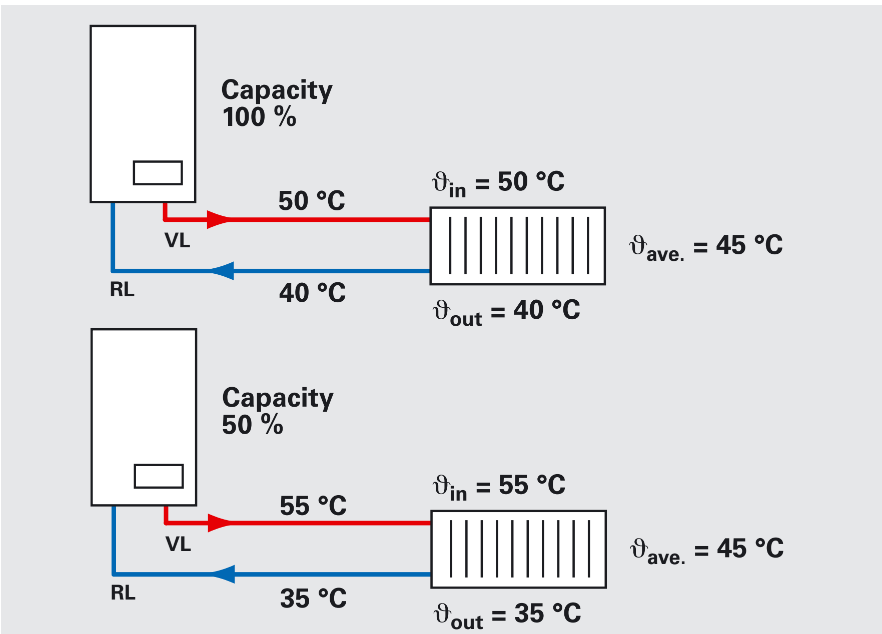


Fig. 36: Influence of sizing on capacity (spread)

5 Condensate treatment

Condensate created in the boiler and in the flue pipe during heating must be discharged. With a gas consumption of 3000 m^3/p.a. for the average detached home, approx. 3000 to 3500 l/p.a. of condensate may be created (Fig. 37).

Subject to the return temperature, a certain flue gas temperature ϑ_A results, which in turn influences the condensate value α. α becomes 1, if the total theoretical condensate volume (Table 1) is created (complete condensation). As the pH value has been shifted towards "acidic", and the condensate may contain substances, the Abwassertechnische Vereinigung [Germany] has published their Code of Practice ATV-DVWK-A 251, on which the waste water regulations of most water authorities [in Germany] are based.

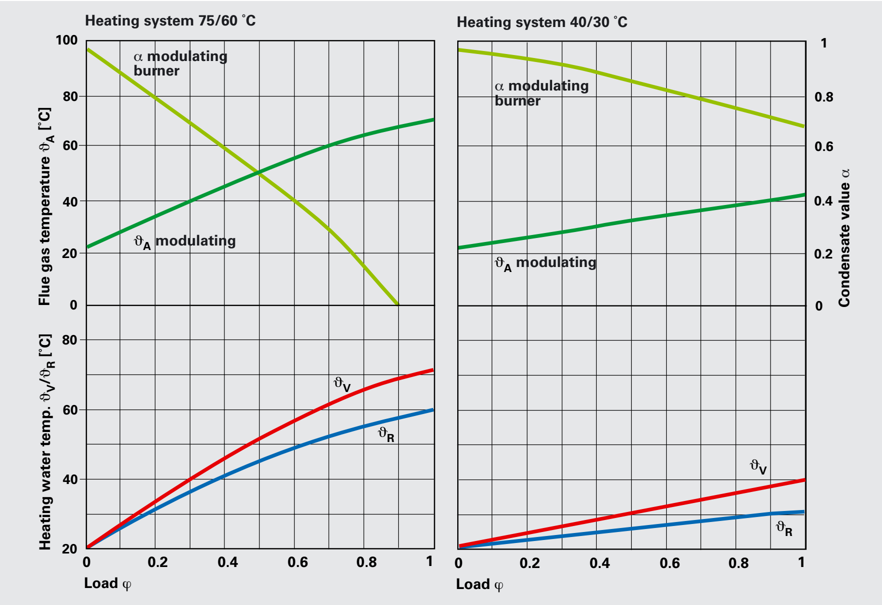


Fig. 37: Condensate

Direct introduction of condensate into the sewer system

For gas fired condensing boilers below 25 kW, condensate may be directly drained into the public sewer (table 4). The proportion of condensate of the total waste water is so small, that domestic waste water provides sufficient dilution. The same applies to oil fired condensing boilers which are operated exclusively with low sulphur fuel oil. Even with a higher rated output up to 200 kW, condensate from gas/oil fired condensing boilers may be safely drained into the public sewer (condition: use of low sulphur fuel oil) without prior neutralisation, provided the framework conditions according to table 5 are being met. These conditions have been determined, so that condensate is diluted with ordinary waste water in a ratio of 1:20.

Permits in connection with draining condensate from all condensing boilers are obtainable from the lower water authority [in Germany], which makes decisions based on local circumstances.

Rated output	**Neutralisation for combustion systems is required for**			**Limitations**
	Gas	Fuel oil to DIN 51603-1 low sulphur	Fuel oil DIN 51603-1	**Neutralisation is still required** 1) when draining domestic waste water into small sewerage treatment plants 2) for buildings, the drainage pipes of which are not resistant to acidic condensate (e.g. galvanised or other material containing copper). 3) if required mixing ratio is not achieved.
Up to 25 kW 25 to 200 kW > 200 kW	no 1), 2) no 1), 2), 3) yes	yes yes yes	no 1), 2) no 1), 2), 3) yes	

Table 4: Compulsory neutralisation subject to boiler output (source: ATV-DVWK)

Materials for condensate lines

Select special materials if one pipe is used exclusively for condensate from the point of insertion to a collection area, and condensate is never diluted, not even occasionally.

According to ATV-DVWK-A 251 Code of Practice, these materials include:
- Vitrified clay
- Hard PVC pipes
- PVC pipes
- PE HD pipes
- PP pipes
- ABS/ASA pipes
- Corrosion-resistant steel pipes
- Borosilicate pipes.

Condensate drains running to the public sewer should be equipped with an inspection port and a stench trap.

Use of neutralising systems

The pH value of the condensate will be shifted towards "neutral" if a neutralising system is prescribed. For this, the condensate is routed through the neutralising system (Fig. 38 & 39). This essentially comprises a tank filled with granulate. Some of the granulate (magnesium hydroxide) dissolves in the condensate, reacts primarily with the carbon dioxide whilst forming a salt, and so shifts the pH value to between 6.5 and 9.

It is important that this system is always operated on a continuous basis to prevent too much granulate being dissolved in idle periods. The tank volume should be matched to the expected condensate volume, and should be sized so that one filling is sufficient for at least one heating season. However, occasional checks should be made within the first few months after installation. The system should also be serviced annually.

In future, oil fired condensing boilers, which are not exclusively operated with low sulphur fuel oil (≤ 50 ppm), must still be equipped with a neutralising system. This comprises a decantation chamber upstream of the neutralisation tank, as well as a charcoal filter to bind oil derivates. The granulate filling for raising the pH value consists of magnesium hydroxide (Fig. 40).

	Combustion output [kW]	25	50	100	150	<200
Domestic houses	Maximum annual condensate volume for natural gas [m³/p.a.]	7	14	28	42	56
	for low sulphur fuel oil EL [m³/p.a.]	4	8	16	24	32
	Minimum number of apartments	1	2	4	6	8
Commercial buildings	Maximum annual condensate volume for natural gas [m³/p.a.]	6	12	24	36	48
	for low sulphur fuel oil EL [m³/p.a.]	3.4	6.8	13.6	22.4	27.2
	Minimum number of employees (office)	10	20	40	60	80

Table 4: Conditions for introducing condensate into the sewer system for condensing boilers in accordance with ATV-DVWK-A 251

Fig. 38: Granulate neutralisation for condensate volumes from gas fired combustion equipment up to 70 l/h, which equals approx. 500 kW output

Fig. 39: Granulate neutralisation with condensate lifting pump – applicable for condensate volumes up to 210 l/h, which equals approx.1500 kW output

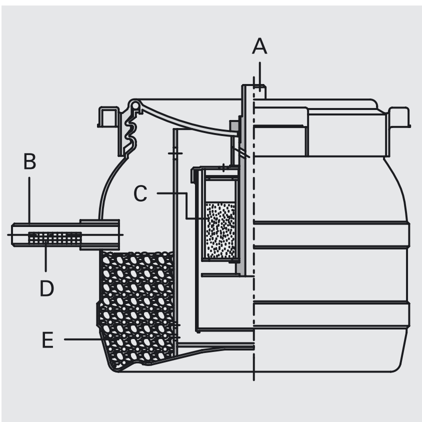


Fig. 40: Neutralising system for oil fired condensing boilers (compulsory for standard fuel oil)

Key:
A Inlet (DN 20)
B Outlet (DN 20)
C Active charcoal filter
D Coloured indicator
E Neutralising granulate

6 Emissions and flue gas system

6.1 Emissions

The particularly clean combustion achieved by modern MatriX radiant burners ensures that Viessmann condensing boilers realise substantially better results than the limits prescribed by all known regulations (Fig. 41). In some cases emissions already fall below technically verifiable levels.
The extremely low emissions achieved by the MatriX radiant burner are the result of the complete premixing of gas and air, as well as the low combustion temperature, which results from the large semi-circular reaction surface.
A high proportion of the released energy is dissipated through infrared radiation from the reaction zone. This significantly reduces NO_x formation.
Blue flame burners should be used for oil fired condensing boilers, since these offer particularly clean combustion.

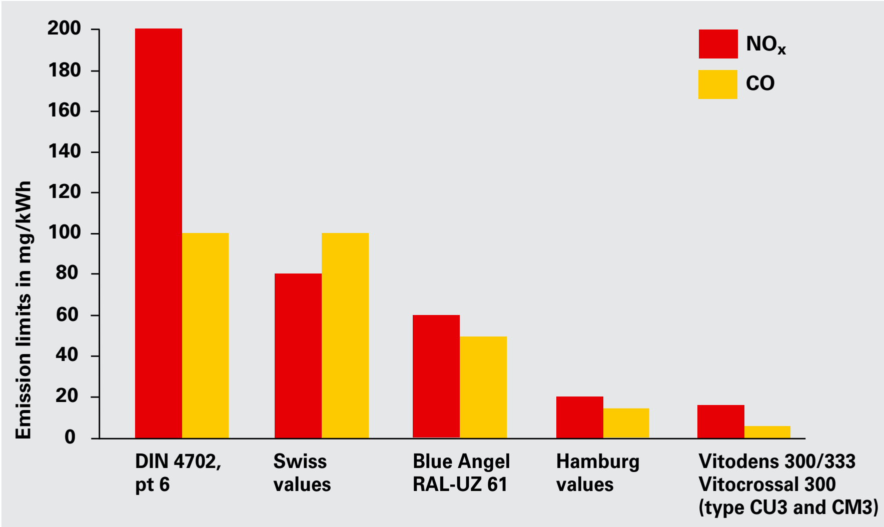


Fig. 41: Emissions characteristics of Vitodens 300/333 and Vitocrossal 300 gas fired condensing boilers (type CU3 and CM3) compared to various regulations and designations

6.2 Flue gas system

The low flue gas temperature (< 85 °C) and the risk of residual humidity condensing in the flue gas system, make a conventional chimney unsuitable for the installation of condensing boilers.
The low flue gas temperature is not always adequate to ensure a thermal current within the flue gas system. Therefore, condensing boilers are frequently equipped with a fan and are operated with positive pressure.
Compared to conventional chimneys, these conditions lead to quite different requirements:
– During operation, there is no requirement for resistance against soot combustion, etc.
– The chimney will be subjected to only minor temperature loads.
– The system may operate with positive or negative pressure.
– Corrosive condensate must be expected.

These conditions can be met by simple flue pipes which are made from plastic, stainless steel, ceramics or glass.

Prior to work on the flue gas system, the heating contractor should confer with the responsible flue gas inspector [where applicable].

Basically, a differentiation is drawn depending on whether the condensing boiler is to be installed
– inside the living space (where people congregate) or
– outside the living space (boiler room).

Installation inside the living space is only permitted up to 50 kW. The system may also be installed inside the living space if the flue pipe, inside the area where people congregate, is run inside a protective pipe and is surrounded by air (fan-assisted system, balanced flue operation). Using a connector, which provides secondary ventilation up to the duct (operation with interconnected room air supply), a condensing boiler may, in exceptional cases, also be installed inside the living space, when it is operated as open flue system.

Outside the living space, the flue pipe may also be installed inside the boiler room without secondary ventilation. In that case, however, the boiler room would require an adequately sized ventilation aperture to the outside (acc. to TGI '86/96).
Rated output up to 50 kW:
150 cm^2 or 2 x 75 cm^2

Rated output above 50 kW (e.g. Vitodens 300, 66.0 kW or multi-boiler systems):
150 cm^2 and an additional 2 cm^2 for each kW output above 50 kW.

If an open-flue boiler (boiler type B) is selected, the combustion air will be drawn from the room where the boiler is installed. Special measures need to be taken so that the living space can make adequate volumes of air available for combustion without sacrificing the ambient climate (interconnected room air supply). The flue pipe should be coaxial until it enters the duct, thus the combustion air supply is effected via the outer pipe casing. Any escaping flue gas is, therefore, directly piped back to the boiler (Fig. 42).
Generally, the following conditions apply:

Permissible:

– Gas fired boilers may be installed on the same floor
– Occupied rooms with interconnected air supply
– Adjoining rooms with interconnected air supply
– Adjoining rooms with interconnected air supply (larders, basements, utility rooms, etc.)

– Adjoining rooms with outside wall apertures (ventilation air/exhaust air 150 cm^2 or 2 x 75 cm^2 each at the top or bottom of the same wall up to $Q_N \leq 50$ kW)
– Attic rooms, but only with adequate minimum chimney height, (acc. to DIN 18160 – 4 m above inlet).

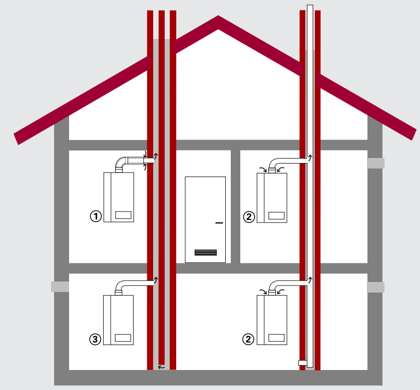
Not permissible:

– Stairwells and common hallways. Exception: detached houses and two-family homes of low height (top edge of the floor in the top floor < 7 m above ground level)
– Bathrooms and toilets without outside windows with duct ventilation
– Rooms in which explosive or flammable materials are stored
– Rooms ventilated mechanically or via individual duct systems to DIN 18117-1.

Balanced flue boilers (boiler type C) draw combustion air from outside the building shell. For this purpose, either the available cross-section of the duct will be used, inside of which the flue pipe is installed, or a coaxial pipe, through the inside of which the flue gas flow is exhausted, whilst combustion air is drawn in through the outer pipe casing. In either case, the flue pipe installed inside the boiler room (flue connector) is surrounded by an outer casing, inside of which the flue pipe is surrounded by secondary ventilation (Fig. 43).

In principle it is possible to connect several condensing boilers to one flue pipe.

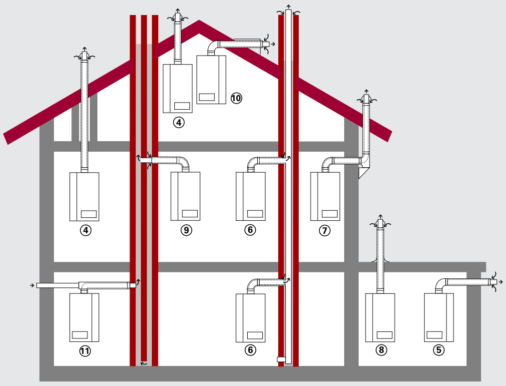
Options are, for example, installation in residential or living rooms, in non-ventilated adjoining rooms, inside cupboards and niches without clearance to combustible materials, as well as in attic rooms (pitched attic and long pane of the roof) with direct outlet of the flue pipe/ventilation pipe through the roof.



Open flue operation:

1 Coaxial pipe connection, combustion air supply with interconnected room supply
2 Multiple connections to a moisture-resistant chimney
3 Connection to a conventional chimney

Fig. 42: Flue gas systems for Vitodens 200 and 300 for open flue operation



Balanced flue operation:

4 Vertical roof terminal
5 Outside wall terminal
6 Sealed balanced flue (multiple connections)
7 Outside wall terminal
8 Vertical roof terminal (flat roof)
9 Existing sealed balanced flue
10 Horizontal roof terminal
11 Separate air supply and flue pipe

Fig. 43: Flue gas systems for Vitodens 200 and 300 for balanced flue operation

Pipes must be routed through a duct if the flue pipe passes through several floors. This duct must be implemented acc. to fire protection class F90; for low duct heights (< 7 m), F30 will be sufficient.

The boiler room must be provided with a condensate drain as well as the safety valve blow-off line.

Electrical interlocks for extract fans (extractor hoods, etc.) are not required for balanced flue operation.

7 Selection guide

7.1 Gas fired wall mounted condensing boilers

Viessmann offers the right condensing solution for every demand. In detached houses, a wall mounted boiler with DHW cylinder or integrated standby instantaneous water heater may be used. Such a boiler may be operated as open flue or as balanced flue system. Such systems can be installed in the attic, in the living space or in a cellar. Alternatively, a freestanding gas fired condensing boiler with separate DHW cylinder may be installed in the basement. A decentralised or central solution may be selected for multi-occupancy houses.

Usually, wall mounted boilers are located in every apartment where heat is generated on a decentralised basis. Domestic hot water is then produced in a cylinder, which may be hung alongside the boiler, or which may be freestanding below or adjacent to the boiler. Alternatively, a plate-type heat exchanger may be integrated inside the condensing boiler to act as instantaneous water heater.

Vitodens 200

Vitodens 200 (Fig. 44) offers high quality condensing technology for central and DHW heating using Inox-Radial heat exchangers and offering a sound cost:benefit ratio. Its compact dimensions and timeless modern design furthermore make it a perfect match for any modern living space. The Inox-Radial heating surface is responsible for its advanced condensing technology. The modulating stainless steel cylinder burner handles energy with the greatest economy. And it reduces emissions, which lie below the limits set for the "Blue Angel" certificate of environmental excellence.

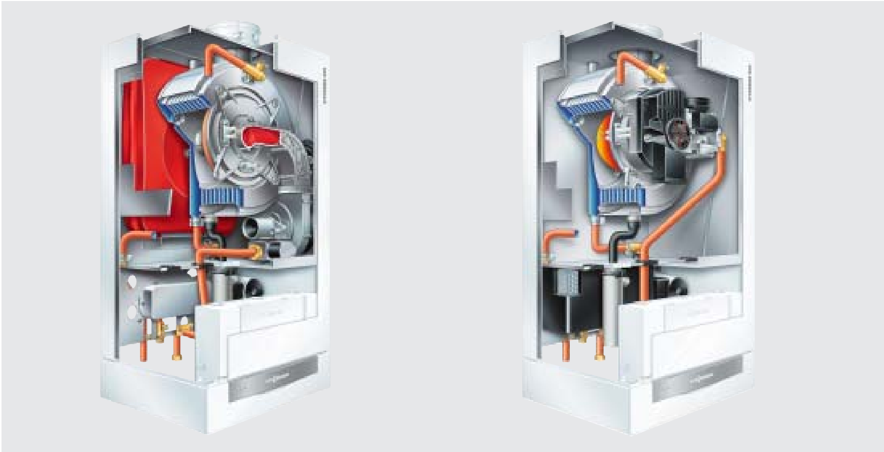


Fig. 44: Vitodens 200 and 300 gas fired wall mounted condensing boilers from 4.5 to 66.0 kW; Vitodens 300 may also be supplied as cascade system up to 264 kW

Vitodens 300

Vitodens 300 (Fig. 44) offers powerful gas fired condensing technology, packed into a compact attractive design. This represents high central heating and DHW convenience, and easy to integrate into the living space. The top combination: the modulating MatriX-compact gas burner and the stainless steel Inox-Radial heating surface for reduced heating costs and environmental responsibility. The emissions fall substantially below the limits set for the "Blue Angel" certificate of environmental excellence. The variable speed AC fan and heating circuit pump are also economical to run.

Control is made easy with the convenient Vitotronic energy management system. Vitodens 300 up to 66 kW as single boiler, and up to 264 kW as multi-boiler cascade, offers a cost-effective and space-saving solution for multi-occupancy blocks and public buildings too.

Vitodens 333

The compact boiler Vitodens 333 combines the Vitodens 300 condensing boiler with a high-output 86 l DHW loading cylinder. Innovative heating technology with an Inox-Radial heating surface and a MatriX-compact burner plus a space efficient modular design ensure high DHW convenience, which is generally only available with DHW cylinders twice the size. The dimensions of Vitodens 333 have been designed to match those of standard kitchen units and white goods, thereby enabling easy and harmonious integration into the living space. A height of just under 140 cm allows it to fit equally well under the eaves and in niches.

Fig. 45: Vitodens 333 – compact gas fired condensing boiler, 4.5 to 26.0 kW with integral loading cylinder (86 litres capacity)

7.2 Oil fired wall mounted condensing boiler

Vitoplus 300

The Vitoplus 300 oil fired condensing boiler (Fig. 46) now brings the benefits of condensing technology to oil fired boilers. As genuine oil fired wall mounted condensing boiler, Vitoplus 300 is as universally and flexibly useful as any gas fired wall mounted condensing boiler. Vitoplus 300 is offered with two output ratings: 12.9/19.3 kW and 16.1/23.5 kW. This enables Vitoplus 300 to cover further applications, mainly for modernisation projects and in larger buildings.

The two stage Compact blue flame burner is characterised by its clean combustion and its reliable, environmentally responsible operation. When using low sulphur fuel oil, the sulphur content of the condensate is comparable with that produced when using natural gas. This makes neutralising unnecessary.

The following operating conditions apply to the whole Vitoplus 300 range:
– Fuel oil with sulphur content up to 500 ppm can be used,
– During the initial fill, optional mixing of low sulphur (50 ppm) with standard fuel oil at a ratio of 3:1,
– One service per year is sufficient.

Its practical usefulness is further enhanced by the ease with which it can be cleaned. The adjustable spiral of the Inox-Radial heating surface makes annual maintenance very easy – indeed it can be relaxed to provide an 8 mm cleaning gap –. This enables unavoidable combustion residues produced by fuel oil to be quickly and thoroughly removed.

Fig. 46: Vitoplus 300 oil fired wall mounted condensing boiler with Inox-Radial heating surfaces and compact blue flame burner, 12.9 to 23.5 kW

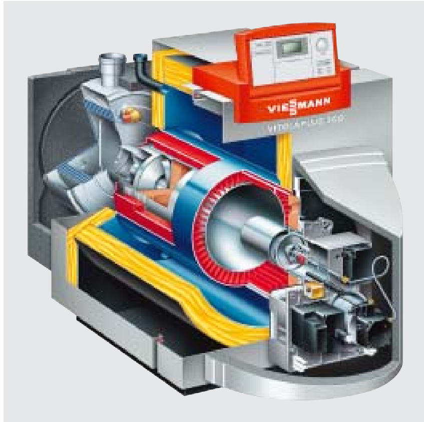


Fig. 47: Vitolaplus 300 oil fired Unit condensing boiler with downstream stainless steel Inox-Radial heat exchanger, 19.4 to 29.2 kW

7.3 Oil fired Unit condensing boiler (freestanding)

Vitolaplus 300

Vitolaplus 300 (Fig.47) is a freestanding oil fired Unit condensing boiler with an attractive cost:benefit ratio, high operational reliability and compact dimensions. For the output range 19.4 to 29.2 kW, Vitolaplus 300 offers an ideal solution for utilising oil fired condensing technology, particularly in modernisation projects. The particular advantage offered by Vitolaplus 300 is its two-stage heat recovery and the combination of proven biferral composite heating surface and the corrosion-resistant Inox-Radial heat exchanger installed downstream of the boiler.

This principle ensures that combustion and condensation occur in physically separate locations. Inevitable combustion residues remain in the easily accessible combustion chamber, leaving the downstream Inox-Radial heat exchanger to effect condensation in a space which is practically free from residues.

In addition, the Vitoflame 300 blue flame Unit burner ensures soot-free, clean and efficient combustion in an environmentally responsible manner. Consequently, Vitolaplus 300 performs better than the limits set for the ”Blue Angel” certificate of environmental excellence.

Vitolaplus 300 can be operated with all commercially available EL fuel oils. A neutralising system is not required when using low sulphur fuel oil.

7.4 Gas fired condensing boiler (freestanding)

Vitocrossal 300

Vitocrossal 300 is a top product amongst freestanding gas fired condensing boilers. From 9 to 978 kW, this range offers the right solution for any demand – for detached homes and apartment buildings, as well as local heating networks or public/commercial buildings. Vitocrossal 300 was combined with another milestone of Viessmann heating technology: the vertically arranged Inox-Crossal heating surface. The smooth stainless steel heating surface allows condensate to simply run off downward. Combined with the smooth stainless steel surfaces, this creates a permanent self-cleaning effect, ensuring the long-term, high utilisation of condensing technology, whilst reducing maintenance requirements and extending its service life. The highly efficient heat transfer and the high condensation rate, enable this boiler to achieve a standard efficiency of up to 109%. This is the result of the countercurrent flow of hot gas and boiler water, as well as the intensive turbulence of the hot gases through the heating surface.

Balanced flue operation is feasible up to 66 kW (Fig. 48). This enables Vitocrossal 300 to be installed inside the thermally insulated building envelope. This is especially advantageous for the EnEV [Germany] calculation. The Inox-Crossal heating surface in Vitocrossal 300 was combined with another milestone of Viessmann heating technology, the MatriX burner up to 142 kW. This reduces heating costs and ensures minimised emissions without compromise. These are so low that Vitocrossal 300 performs significantly better than the limits set for the "Blue Angel" certificate of environmental excellence. Two return connectors on Vitocrossal 300 (187 to 978 kW) (Fig. 49) enable the separate connection of heating returns with lower temperatures. This improves hot gas condensation.

Fig. 48: Freestanding Vitocrossal 300 gas fired condensing boiler with MatriX gas burner

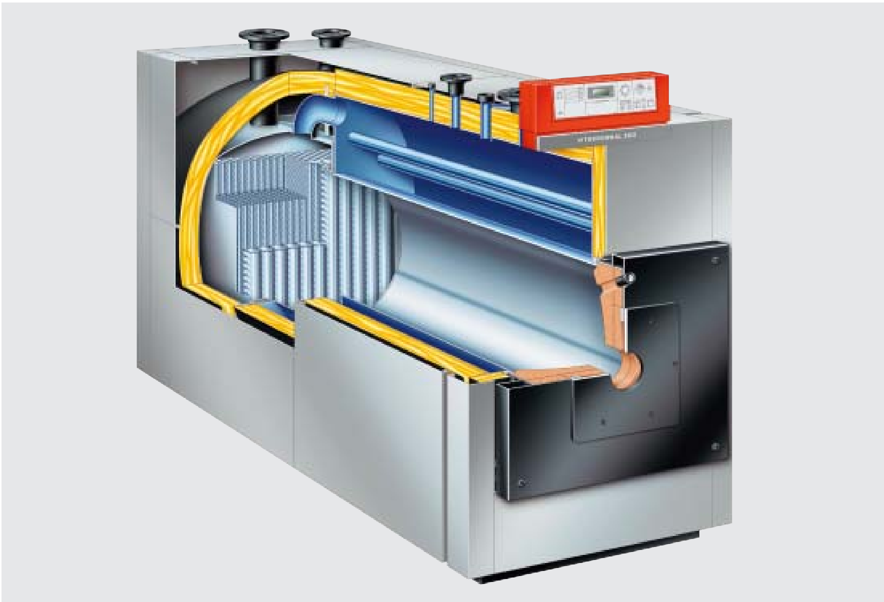


Fig. 49: Freestanding Vitocrossal 300 gas fired condensing boiler with Inox-Crossal heating surface, 187 to 978 kW

7.5 Flue gas/water heat exchanger

Vitotrans 333

The Vitotec range of freestanding condensing boilers is supplemented by the stainless steel Vitotrans 333 flue gas/water heat exchanger, for systems with 80 to 6600 kW output. Flue gas/water heat exchangers are installed downstream of the boiler, particularly in the higher output ranges, to utilise condensing technology (Fig. 50).

The flue gas temperature is dramatically reduced in the Vitotrans 333 flue gas/water heat exchangers (Fig. 51) and reaches levels only 10 to 25 K higher than the heating water return temperature. This alone raises the efficiency by approx. 5%. The further energy savings and the real advantage of condensing flue gas heat exchangers lies in the utilisation of that energy, which is released when hot gases condense on the cold heating surfaces. Subject to the heating water temperature inside the flue gas/water heat exchanger, the additional energy gain through condensation can reach 7%.

Installing a downstream Vitotrans 333 flue gas/water heat exchanger when using natural gas can raise the standard efficiency by up to 12%, and when using fuel oil by up to 7%.

Vitotrans 333 is available in two versions for different output ranges. Up to 1750 kW, it is equipped with the Inox-Crossal heating surfaces (Fig. 28), and from 1860 to 6600 kW it is equipped with the Inox-Tubal heat exchanger pipes.

Both flue gas/water heat exchangers are highly efficient and are made from stainless steel. This prevents the risk of corrosion through acidic condensate. The countercurrent principle of flowing boiler water and hot gases in opposite directions creates a particularly high condensation rate. The vertical layout supports the self-cleaning effect: any condensate can drain off freely downward. In doing so, it flushes the heating surfaces and keeps them clean.

Fig. 50: Vitoplex 300 with downstream Vitotrans 333 flue gas/water heat exchanger for the utilisation of condensing technology with boilers from 80 to 6600 kW

Fig. 51: Vitotrans 333 flue gas/water heat exchangers with Inox-Crossal heating surfaces and Inox-Tubal heat exchanger pipes

7.6 Selection table for wall mounted combination/conventional boilers with focus on DHW heating

The operation of Viessmann wall mounted boilers is particularly user-friendly, both through uncomplicated controls and convenient DHW loading, utilising the integral Quick DHW heating system. Plate heat exchangers provide hot water in combination boilers – without wasting unnecessary energy or water consumption.

The extensive Vitocell range of cylinders covers higher water demands, i.e. from 80 to 300 litres. Whether DHW cylinders are installed as wall mounted devices, or below/adjacent to the boiler, their shape or colour always matches Viessmann wall mounted boilers. The associated connection sets make installation quick and easy.

Table 6 provides some assistance in selecting either a wall mounted combination boiler (incl. standby instantaneous water heater) or a boiler with separate DHW cylinder with special focus on DHW heating.

Condensing technology offers particular advantages for building renovation, as simple and cost-effective solutions can be found for the flue gas side of the system. Extensive chimney work involving brickwork is not required; instead the simple insertion of plastic flue pipes into existing ducts will normally suffice. Alternatively direct access to outside air will be created through small wall apertures.

Table 6: Selection table to assist in selecting either a combination boiler with integral standby instantaneous water heater or a boiler with separate DHW cylinder

		Combination boiler with standby instantaneous water heater	Boiler with separate DHW cylinder
Hot water demand, convenience	DHW demand for an apartment/flat	+	+
	DHW demand for a detached house	0	+
	Central DHW demand for an apartment block	–	+
	Decentralised DHW demand for a multi-occupancy house	+	+
Utilising several connected draw-off points	One draw-off point	+	0
	Multiple draw-off points, no simultaneous use	+	0 / +
	Several draw-off points, simultaneous use	–	+
Distance of the draw-off point from the boiler	Up to 7 m (without DHW circulation line)	+	–
	With DHW circulation line	–	+
Modernisation	Existing DHW cylinder	–	+
	Replacement of an existing combination boiler	+	– / 0
Space requirement	Low space requirement (installation in a niche)	+	0
	Sufficient space (boiler room)	+	+

+ = recommended
0 = qualified recommendation
– = not recommended

7.7 Modular design from Viessmann

Installation, service and maintenance are made easy by the platform-based modular design from Viessmann. This enables the coming together of the basic chassis and various function modules to create individual boiler types.

This is genuine system design: saving you time and money

Every element of the Vitotec range is rigorously designed for sound function – that goes for the new wall mounted boilers, too. Modular design, with its clear structure and uniformity, creates the basis for high efficiency – from initial design to final operation. Different boiler versions can be assembled from a total of four energy cells, three aqua plates and two types of control unit. This creates a comprehensive product range with a high degree of component uniformity (Fig. 52).

Less means more: harmonisation of components

Viessmann continues to harmonise the components utilised in different boiler versions. Identical elements are used everywhere. The few types of different boilers can bring many benefits:

- Time savings through uniform installation steps
- Quicker and more economical commissioning
- Easy service, simplified maintenance
- Fewer spare parts
- Modular design means fewer sources for potential faults and less training required.

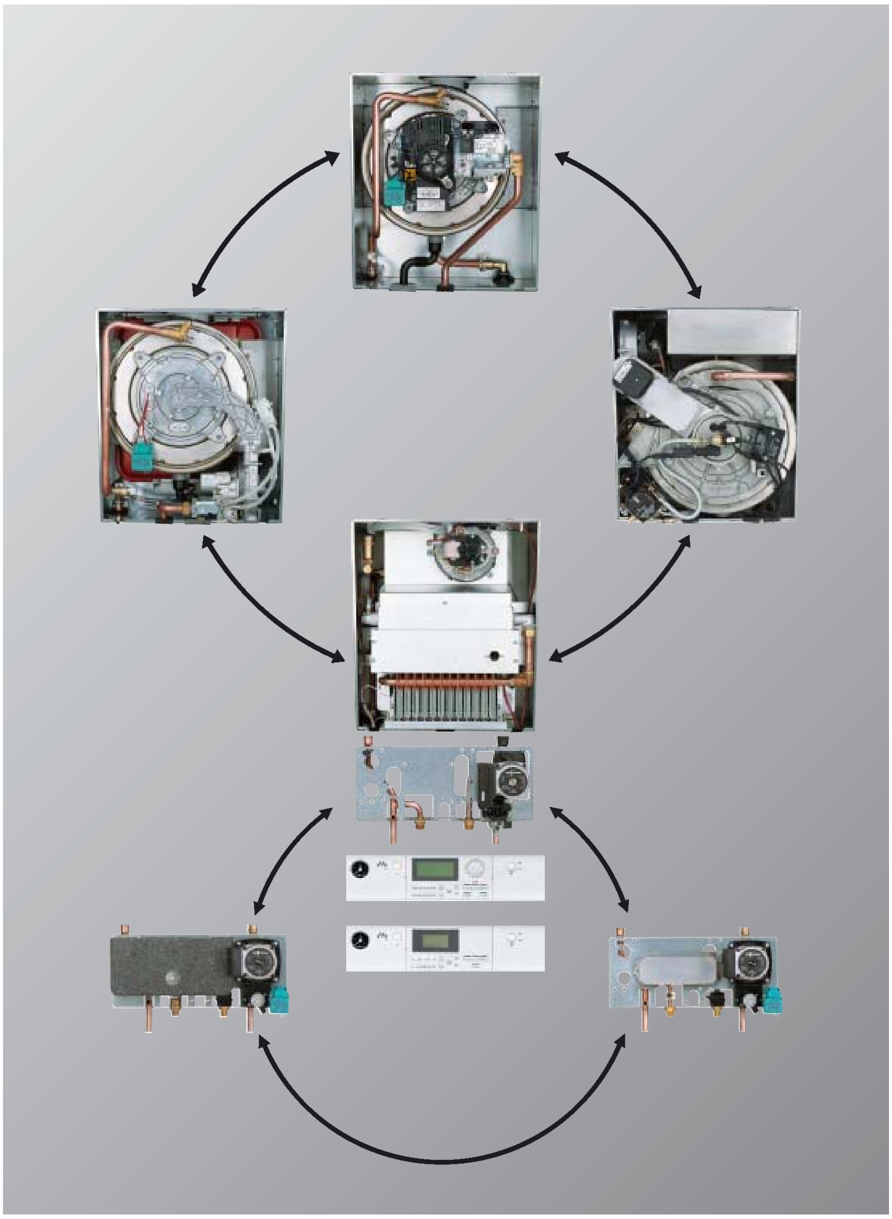


Fig. 52: The consistent application of Viessmann's modular design philosophy ensures that the chassis can be combined with various function modules to create different boiler versions. This enables the use of many standardised components and uniform, easy to learn installation steps.

Viessmann offers you a diverse range of products, which are uniform in quality and adaptable enough to be able to meet any demand and any requirement

Wall mounted oil and gas fired condensing boilers

The Viessmann Group

The Viessmann Group employs approximately 6800 staff worldwide and is one of the foremost manufacturers of heating equipment. For freestanding boilers, Viessmann is the most successful brand in Europe. The Viessmann brand stands for competence and innovation. The Viessmann Group offers a comprehensive range of top-quality, high-tech products, along with perfectly matched modular components. For all their diversity, our products have one thing in common: a consistently high standard of quality that is reflected in operational reliability, energy savings, environmental compatibility and user-friendliness.

Many of our developments point the way forward for the heating sector, both in terms of conventional heating technologies and in the field of renewable forms of energy, such as solar and heat pump technology.

In all our developments we pursue our philosophy of always achieving the greatest possible benefit: for our customers, the environment and our partners, the heating contractors.

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