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Planning Documents

for Wood Chip Boiler



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1 General information

Dear customer,

This planning document contains extensive information for the construction of your wood chip heating. You can determine which ETA boiler is most suited to your requirements in chapters 2 "ETA boilers" and 12 "Technical data".

Information for calculating the annual fuel requirement and the dimensioning of the floor agitator can be found in chapter 4.2 "Fuel store". The different fuel discharge variants are listed in chapter 4.4 "Conveying system variants".

Further possibilities for filling the fuel storage are described in chapter 5 "Filling systems".

To ensure that the required emission limits can be met even with poorer quality fuels, optional external precipitators are available for retrofitting, see chapter 6 "External EEP precipitator".

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2 ETA boilers

2.1 eHACK wood chip boiler

Efficiency and flexibility

The eHACK is the ideal boiler for agriculture and businesses. Depending on the requirements, the boiler is available with output ratings from 20 to 240 kW.



Fig. 2-1: eHACK 20-50 kW

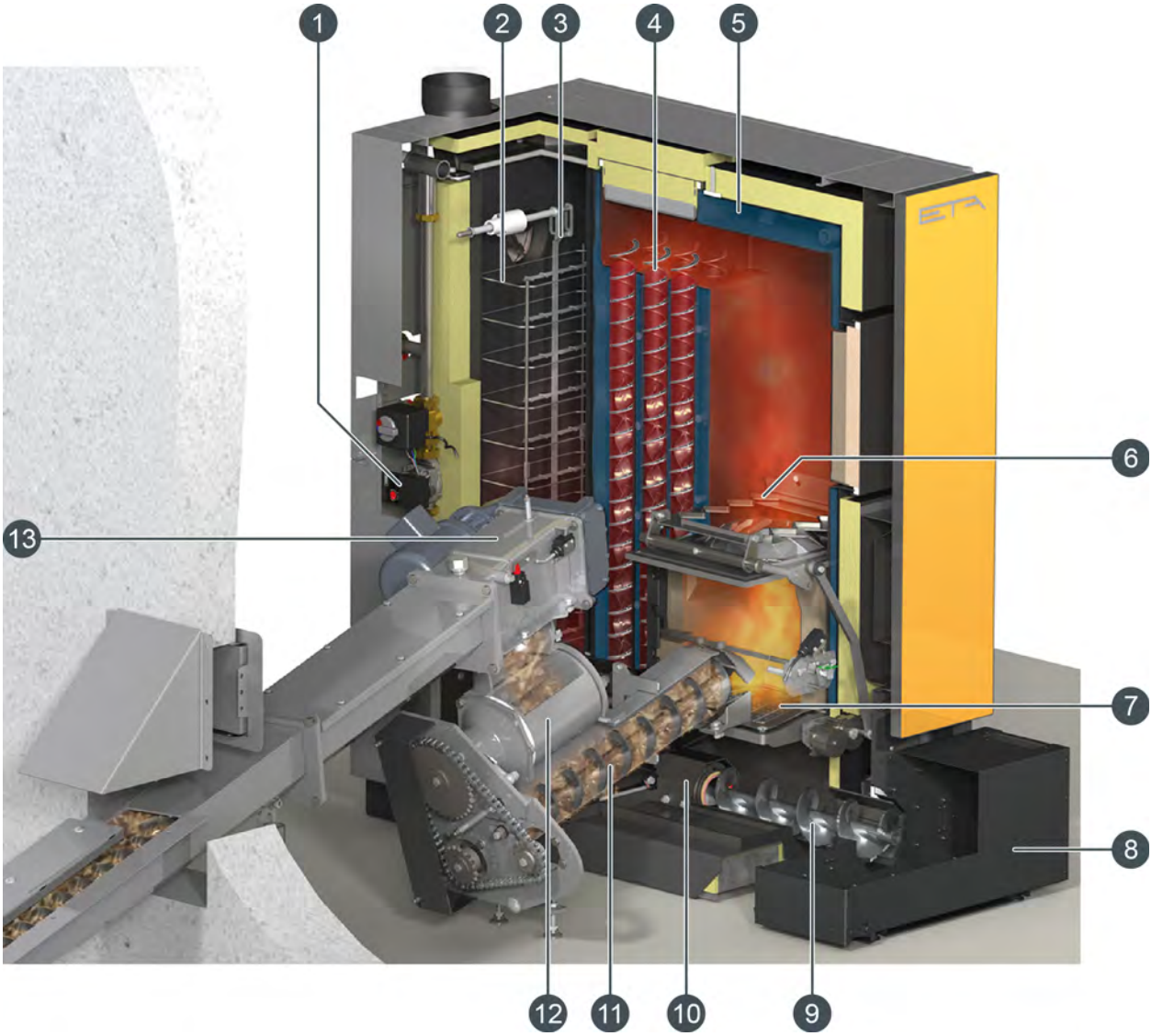
With the optional flue gas recirculation, the boiler can also be operated with pellets or miscanthus. The flue gas recirculation ducts are already integrated into the boiler as standard. Only the actuator for regulating the exhaust gas quantity needs to be installed.

An optional and integrated precipitator is available for the boiler. This can be retrofitted in the boiler at a later time, and therefore does not require any space in the boiler room. The precipitator is automatically completely cleaned during de-ashing. The dust then lands in the ash box along with the remaining ash from the boiler. With a separating ratio of 80-85%, the precipitator ensures low dust emission at minimum power consumption even with poorer quality fuels.

The boiler can be expanded with external de-ashing instead of the ash box. The larger ash bin with a capacity of 320 litres or 240 litres allows for longer boiler runtimes. See chapter 2.1.1 "External ash removal" for details on the external de-ashing.

An overview of the benefits

- With the optional and integrated flue gas recirculation, optimum combustion of the dry fuels takes places in a narrow, slag-free temperature range.
- With the optionally retrofittable precipitator in the boiler, the flue gas is additionally cleaned. This results in low particle emissions even with poor quality fuel.
- A return riser with pump and mixer is already integrated into the boiler.
- The hot and fully refractory-lined combustion chamber guarantees optimum combustion.
- The single-chamber rotary valve ensures maximum burn-back safety.
- The Lambda probe ensures maximum efficiency with lowest emissions.
- Comfortable and automatic heat exchanger cleaning and de-ashing in the external ash box.
- Virtually silent draught fan.
- The ETAtouch control system can be remote controlled via the internet. This includes complete control of the heating system as well as any connected solar heating systems.
- Permanent monitoring of all states of the boiler (such as draught fan speed, residual oxygen content, exhaust temperature, current draw of the drives...) ensures safe operation.



1 Integrated return riser
2 Cleaning cage for cleaning the inner walls of the precipitator
3 Precipitator discharge electrode
4 Turbulators
5 Heat exchanger
6 Ash rake
7 Rotating grate
8 Ash box
9 Ash screw
10 Rotating screw (for combining the ash from the heat exchanger with the ash below the tilting grate)
11 Stoker screw
12 Single-chamber rotary valve (for the fuel)
13 Fuel conveying system

Boiler functionality

The fuel is transported from the conveying system to the single-chamber rotary valve on the boiler. The airtight single-chamber rotary valve keeps the combustion chamber safely separated from the fuel deposit in all operating modes. This way, no hot gas can enter the fuel conveying system, so that ignition of the fuel is impossible. This is the most reliable burn-back protection possible. The fuel is pushed from the stoker screw onto the grate in the combustion chamber, where it is ignited by two ceramic ignition elements.

The regulated draught fan generates a vacuum in the boiler. The primary air flowing through due to this is fed to the fuel under the grate. With the optional and internal flue gas recirculation, a portion of the flue gas is also mixed with the primary air. The firebed is supplied with secondary air across two levels to ensure clean, low-emission burnout.

The quantity of primary air is controlled by the draught fan, and the quantity of flue gas by the optional flue gas recirculation air valve. The flue gas recirculation regulates the combustion chamber temperature. The admixture of the flue gas increases the gas flow in the boiler and thus reduces the combustion temperature. This provides a stable temperature window for combustion, so that even very dry fuel can be burned efficiently.

After combustion, the hot flue gas rises to the upper portion of the secondary combustion chamber. From there, it flows into the heat exchanger equipped with turbulators and delivers the heat to the heating water. Thereafter, it is deflected through the optional precipitator (in which it is additionally cleaned) and into the chimney via the draught fan. The resulting ash collects at the bottom of the heat exchanger.

The entire de-ashing takes place via a drive positioned on the back of the boiler (100 kW boilers and larger have two drives). This drives the ash screw, the turbulators and the push floor in the heat exchanger. The push floor slides the accumulated ash under the heat exchanger and the optional precipitator to the central ash screw. This rotates and pushes the ashes further toward the rotary screw seal.

The rotary screw seal closes sealed between the heat exchanger and the combustion chamber. The ash flows from the heat exchanger to the ash screw beneath the combustion chamber via an internal system of openings and chambers. The ash from the combustion chamber is mixed and transported from the ash screw into the removable ash box.

Flue gas control by the precipitator

Additional purification of the flue gas takes place with the optional precipitator. Inside the precipitator is the centrally positioned and vertically oriented "discharge electrode," which is connected to the high voltage unit. The draught fan sucks the boiler flue gas through the precipitator. It is deflected on the precipitator bottom and sucked between the inner wall and the electrode to the flue gas connection by the electrical field.



Fig. 2-2: Precipitator

The flue gas is cleaned as it flows through the electrical field. In the electrical field (up to 30 kV voltage), the electrode "pushes" the dust particles from the flue gas to the inner wall of the precipitator. The dust particles settle there and can no longer escape with the flue gas via the chimney. Small quantities of dust will remain adhered to the electrode. Therefore, it is cleaned at regular intervals.

Deposits on the inner walls are removed by a cleaning cage, which moves up and down. The sliding rake operates at the same time as the de-ashing of the boiler. The ash is transported on the bottom to the ash box by an ash screw.

2.1.1 External ash removal

Description

The external de-ashing can be optionally aligned to the left or right side of the boiler. We recommend installing it so that the ash bin is on the opposite side of the fuel discharge (stoker or pellet hopper). This ensures that the boiler maintenance areas and the ETAtouch screen remain accessible.

A 240 litre or 320 litre ash bin is available for storing the ashes. The connections for the two ash bins are identical, so they can be exchanged later.

Check the fill level either by opening the ash bin on the upper side or by tapping on the vertical container wall. A full ash bin makes a short, dull thump. When empty it makes a more hollow sound like a drum.

The graphics below show the external de-ashing for the "eHACK" boiler; it is essentially the same for the "ePE-K" pellet boiler.

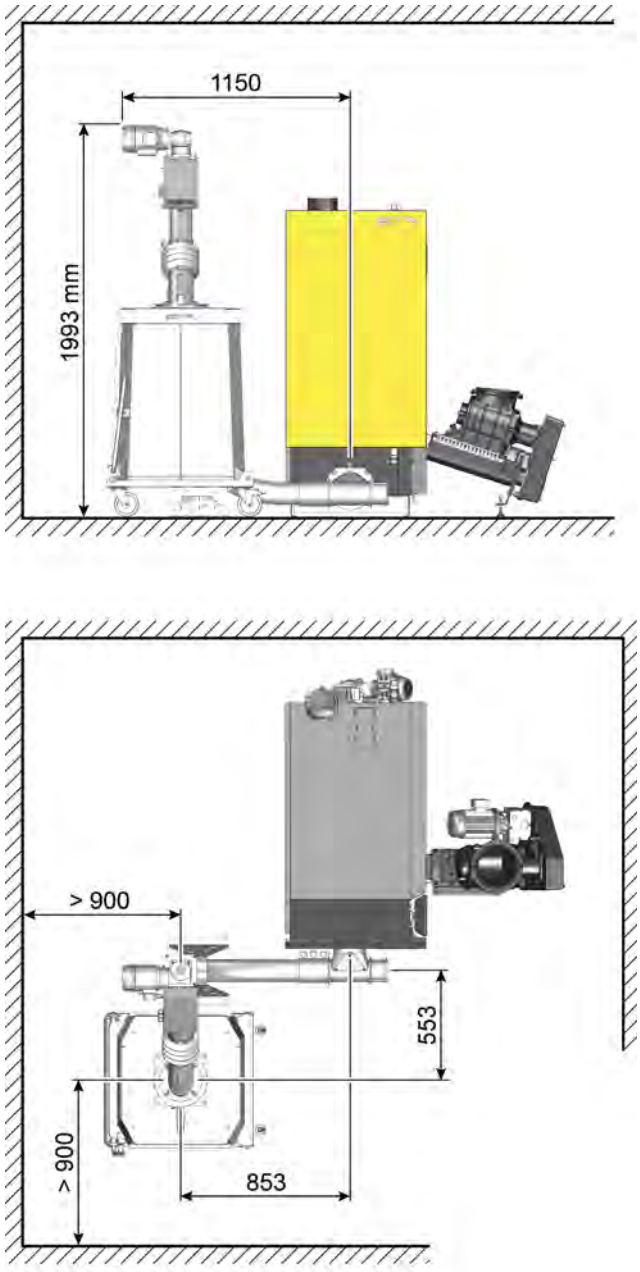


Fig. 2-3: Dimensions (320 litre ash bin)

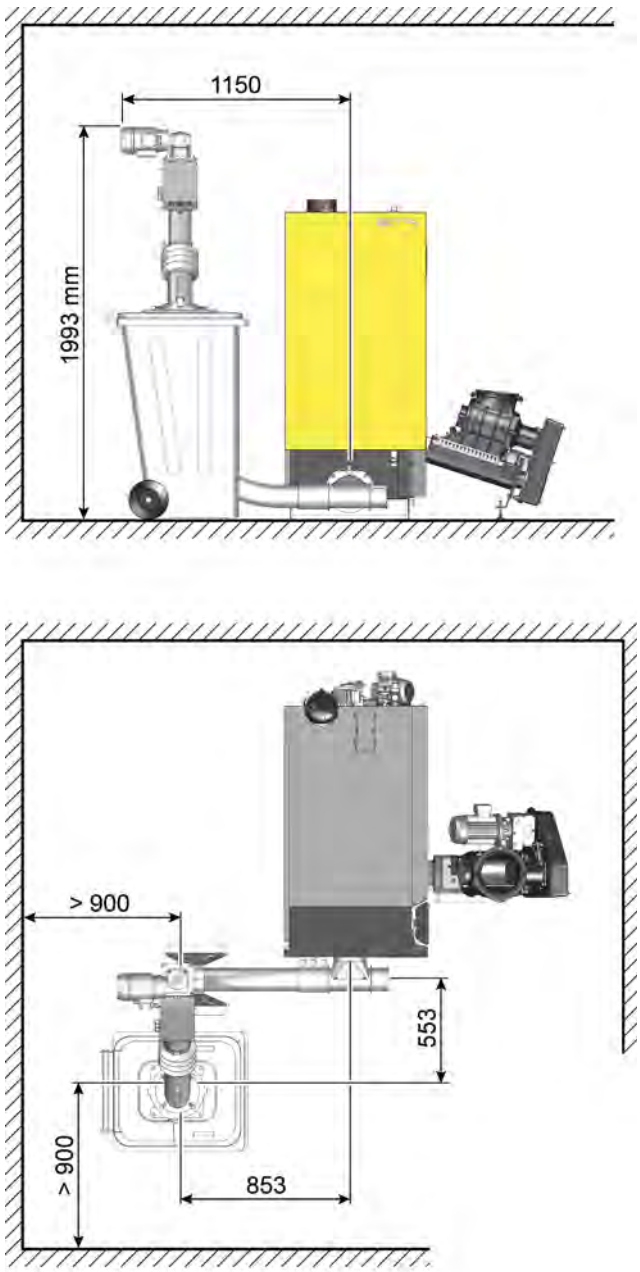


Fig. 2-4: Dimensions (240 litre ash bin)

2.2 HACK VR moving grate boiler

The boiler for industry, businesses and heating networks

The performance class of the HACK VR moving grate boiler with 250-500 kW output is mainly required for industry and commercial buildings. This boiler is also highly suited for heating networks. Thanks to the networking of several boilers (cascade), outputs beyond 1000 kW can be easily achieved. Heating networks can be expanded, and therefore the necessary installation space for additional boilers should be taken into account during planning.

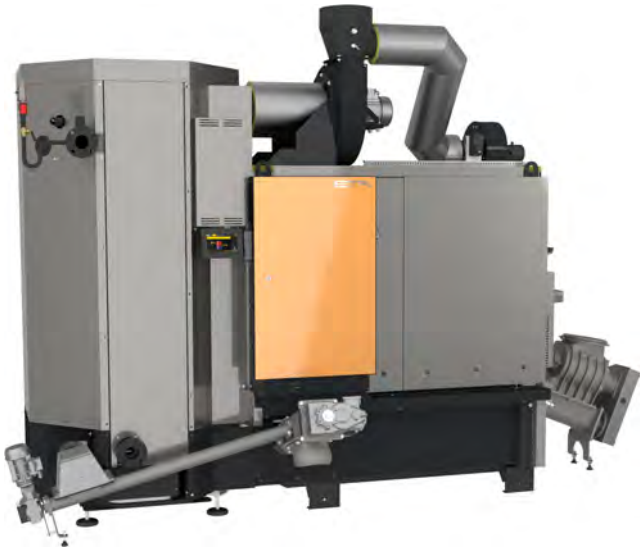


Fig. 2-5: HACK VR 333 - 350 kW

The combustion takes place on a moving grate, which steadily stirs the firebed. At the same time, de-ashing is undertaken, which allows the boiler to be continuously heated while de-ashing takes place. The de-ashing of the combustion chamber and of the heat exchanger is carried out with an external de-ashing extension.

With the standard ETA Hack VR flue gas recirculation, you are flexible in your choice of fuel, because the best efficiency is achieved not just with wood chips, but also with pellets.

Two versions are available for boiler de-ashing - either de-ashing with a downpipe or as de-ashing with an ash flap. See chapter 2.2.1 "External ash removal" for more information.

An overview of the benefits

- The moving grate with individual, angled grate elements that work upwards ensures a complete burnout with the lowest emissions.
- With the series-standard flue gas recirculation, optimum combustion takes place within a narrow, slag-free temperature range.
- Continuous de-ashing of the boiler allows continuous heating operation.
- Complete and automatic de-ashing of the heat exchanger and the combustion chamber into external ash trays or into a container provided by the customer.
- The combustion chamber and the heat exchanger are mechanically separated from one another. Thus, thermal stresses are not a problem. Furthermore, this construction makes the transport, placement and installation easier.
- The single-chamber rotary valve ensures maximum burn-back safety.
- The Lambda probe ensures maximum efficiency with lowest emissions.
- The ETAtouch control system can be remote controlled via the internet. This includes complete control of the heating system as well as any connected solar heating systems.
- Permanent monitoring of all states of the boiler (such as draught fan speed, residual oxygen content, exhaust temperature, current draw of the drives...) ensures safe operation.

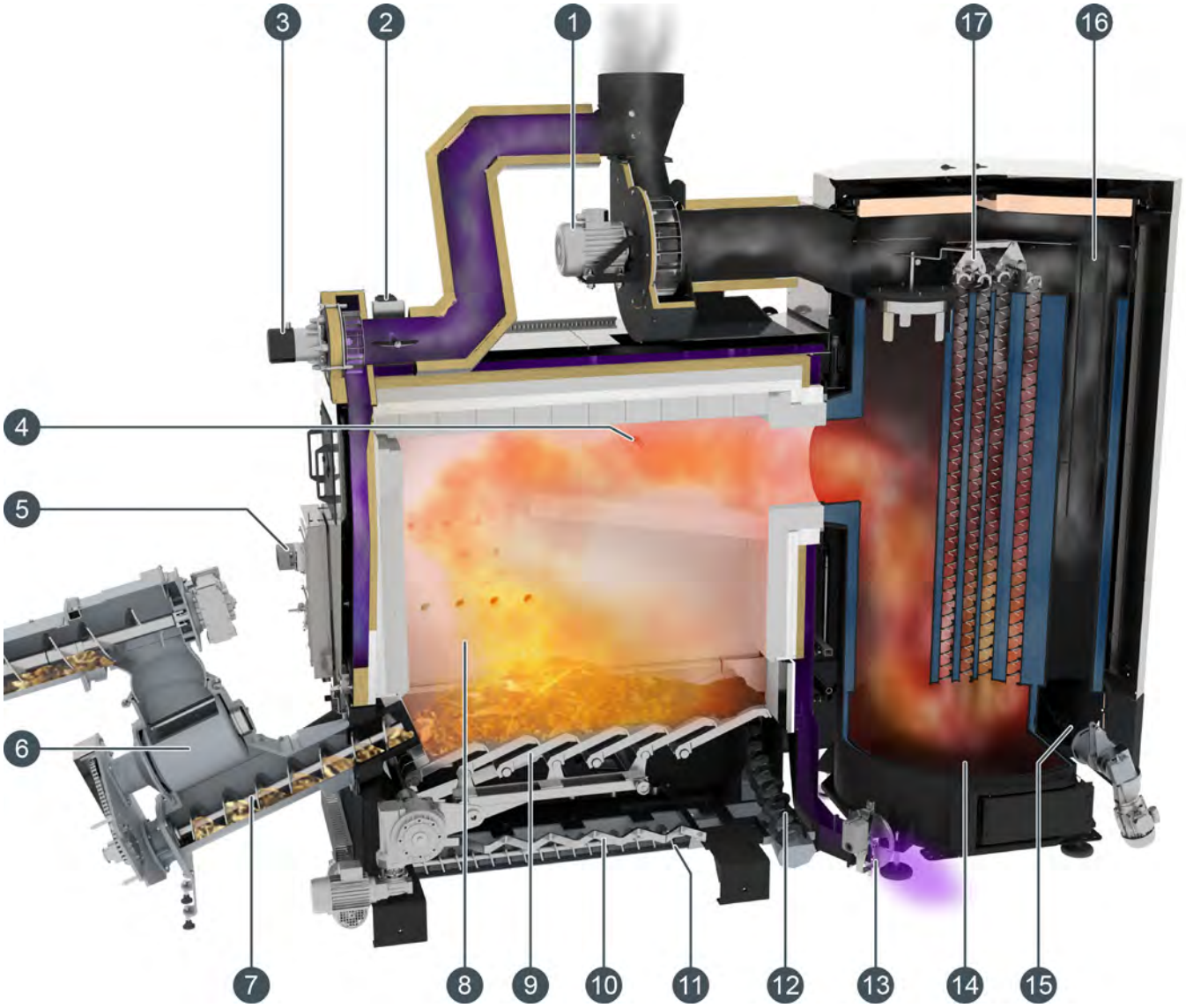


Fig. 2-6: HACK VR 333 - 350 kW

1 Draught fan
2 Flue gas recirculation flap
3 Flue gas recirculation fan
4 Combustion chamber temperature sensor
5 Primary air valve
6 Single chamber rotary valve
7 Stoker screw
8 Combustion chamber
9 Moving grate
10 Ash rake
11 Grate ash screw
12 Cross ash screw
13 Secondary fan
14 Heat exchanger reversing chamber
15 Heat exchanger ash screw
16 Cyclone tubes for large dust particle separation
17 Heat exchanger with automatic cleaning

Boiler functionality

The fuel is transported from the conveying system to the single-chamber rotary valve on the boiler. The airtight single-chamber rotary valve keeps the combustion chamber safely separated from the fuel deposit in all operating states. This way, no hot gas can enter the fuel conveying system, so that ignition of the fuel is impossible. This is the most reliable burn-back protection possible.

The fuel is pushed from the stoker screw onto the moving grate in the high-temperature combustion chamber, where it is ignited by two ignition fans. The individual elements of the moving grate point diagonally upwards, ensuring constant stirring of the firebed. This ensures complete burnout at minimal emissions, and reliably prevents slag formation.

The moving grate and ash rake are driven jointly by just one drive. The stoking intervals vary depending on the residual oxygen (lambda control), the temperature in the combustion chamber and the required power.

Ashes are continuously removed from the combustion chamber by the grate ash screw and cross ash screw. The system therefore does not need to be switched off for ash removal.

The regulated draught fan generates a vacuum in the boiler. The primary air that flows in as a result is mixed with some of the flue gas from flue gas recirculation and added to the fuel beneath the moving grate. The air mixture reaches the fuel via the openings in the grate elements.

The quantity of primary air is controlled by the draught fan, and the quantity of flue gas by the flue gas recirculation flap and flue gas fan. The moving grate supplies the firebed with secondary air, to ensure clean, low-emission burnout.

The temperature of the combustion chamber is controlled by the flue gas recirculation flap. The flue gas is supplied both above and below the grate. This provides a stable temperature window for combustion, so that even very dry fuel can be burned efficiently.

The hot flue gas rises into the upper section of the combustion chamber - into the so-called burnout zone. From here, it flows into the heat exchanger, and is then conveyed downward into the reversing chamber. There, it is diverted into the vertical tubes of the heat exchanger. This enables optimum heat transfer and easy, fully automated cleaning of the entire heat exchanger surface.

The two vertical swirl tubes form a multi-swirl dust separator, which is integrated in the heat exchanger as standard. This separates out coarse dust, prevents dangerous flying sparks and ensures low dust emissions.

The heat exchanger ash screw transports produced ash out of the multi-cyclone and conveys it together with the grate ash to the external de-ashing extension.

The retort and heat exchanger are mechanically separate from one another, and are only screwed together via the connecting flange on installation.

2.2.1 External ash removal

Technical data for the de-ashing system

Two variants are possible for the external de-ashing system of the boiler:

1) De-ashing with a downpipe:
   The ash falls into an ash bin with 240 litre or 320 litre capacity via a downpipe. The connections for the two ash bins are identical, so the ash bins can be exchanged later.
2) De-ashing with an ash flap:
   A flap in the ejector dumps the ash into a container underneath. ETA offers an ash bin with a 770 litre or 320 litre capacity for this purpose. With this de-ashing variant, the customer can also use a different ash bin (or container).

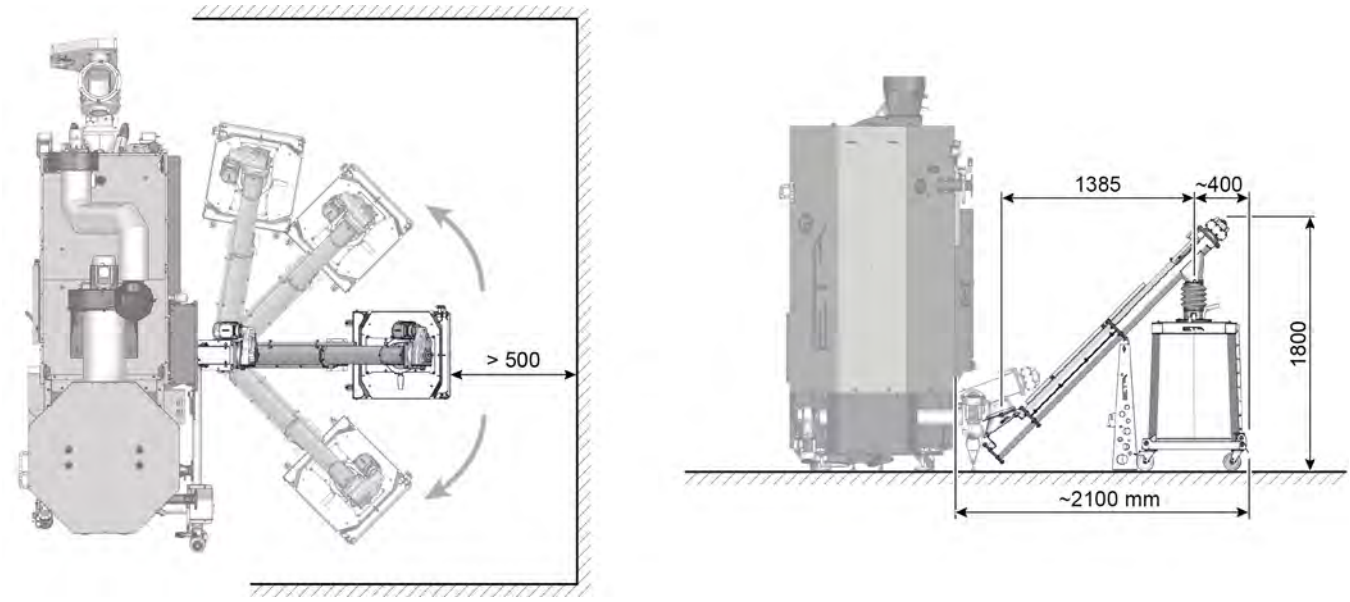


Fig. 2-7: De-ashing with downpipe (with 320 litre ash bin)

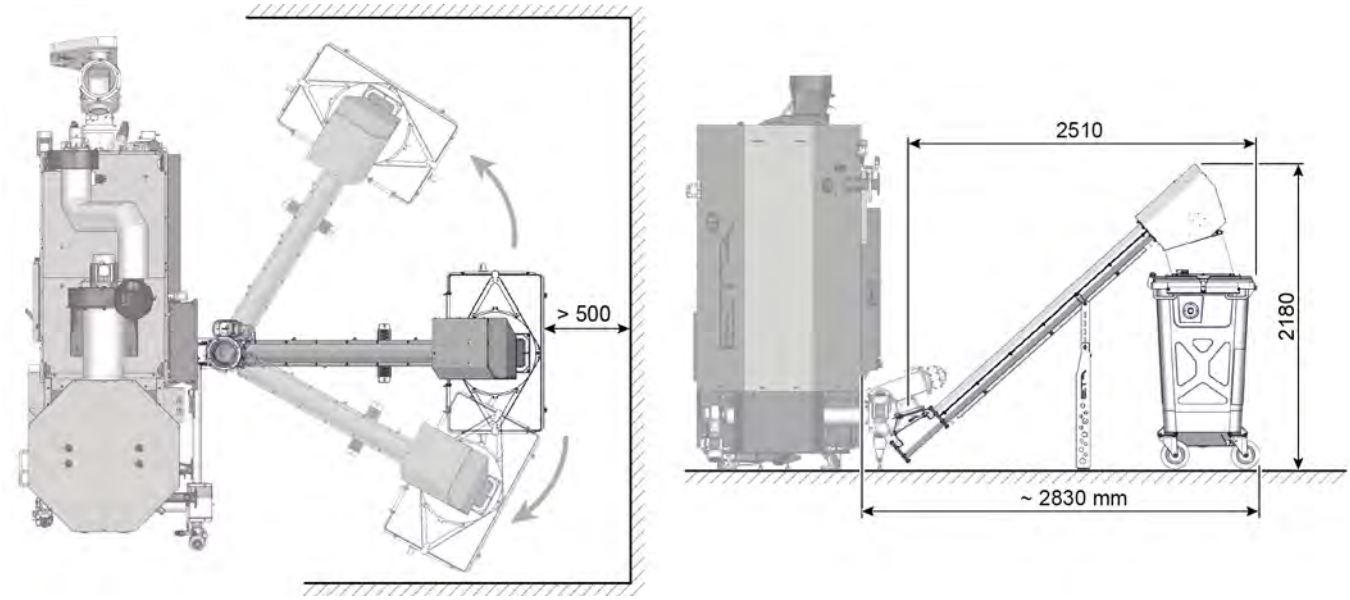


Fig. 2-8: De-ashing with an ash flap (with 770 litre ash bin)

3 Remote control

Remote control of the boiler via the internet

All boilers with the ETAtouch control system can be controlled remotely via smartphone, tablet or PC. The boiler's touch screen is connected to the Internet via a network cable.



A LAN socket near the boiler is required for the internet connection. If none are available, an internet connection can be established using a dLAN adapter via the in-house power grid. This dLAN adapter is also available from ETA.

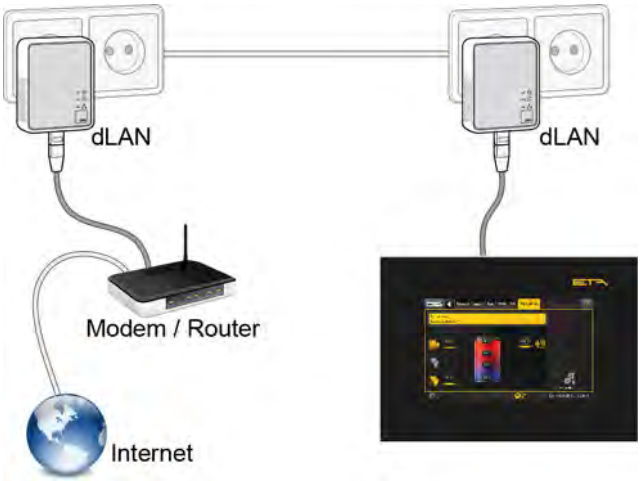


Fig. 3-1: dLAN network

Worldwide access via www.meinETA.at

Remote control via the free internet platform ***www.meinETA.at***.
After registering on this platform, the boiler can be controlled remotely. It can be accessed by smartphone, tablet or PC and is, of course, protected by username and password. You can also access the boiler's control system via your home network with a free VNC Viewer. To see how remote operation of your boiler works, please visit *www.meinETA.at*.

meinETA: the free internet platform

If your heating boiler is connected to the internet, you can see and change all heating settings on your mobile, tablet or PC. So you always have a handle on your heating, wherever you are! When you login to www.meinETA.at, you see the touchscreen as if you were standing right in front of the boiler!

The ash bin must be emptied, it's time for the next heating service... no need to remember all of these tasks, as meinETA will remind you free of charge by e-mail.

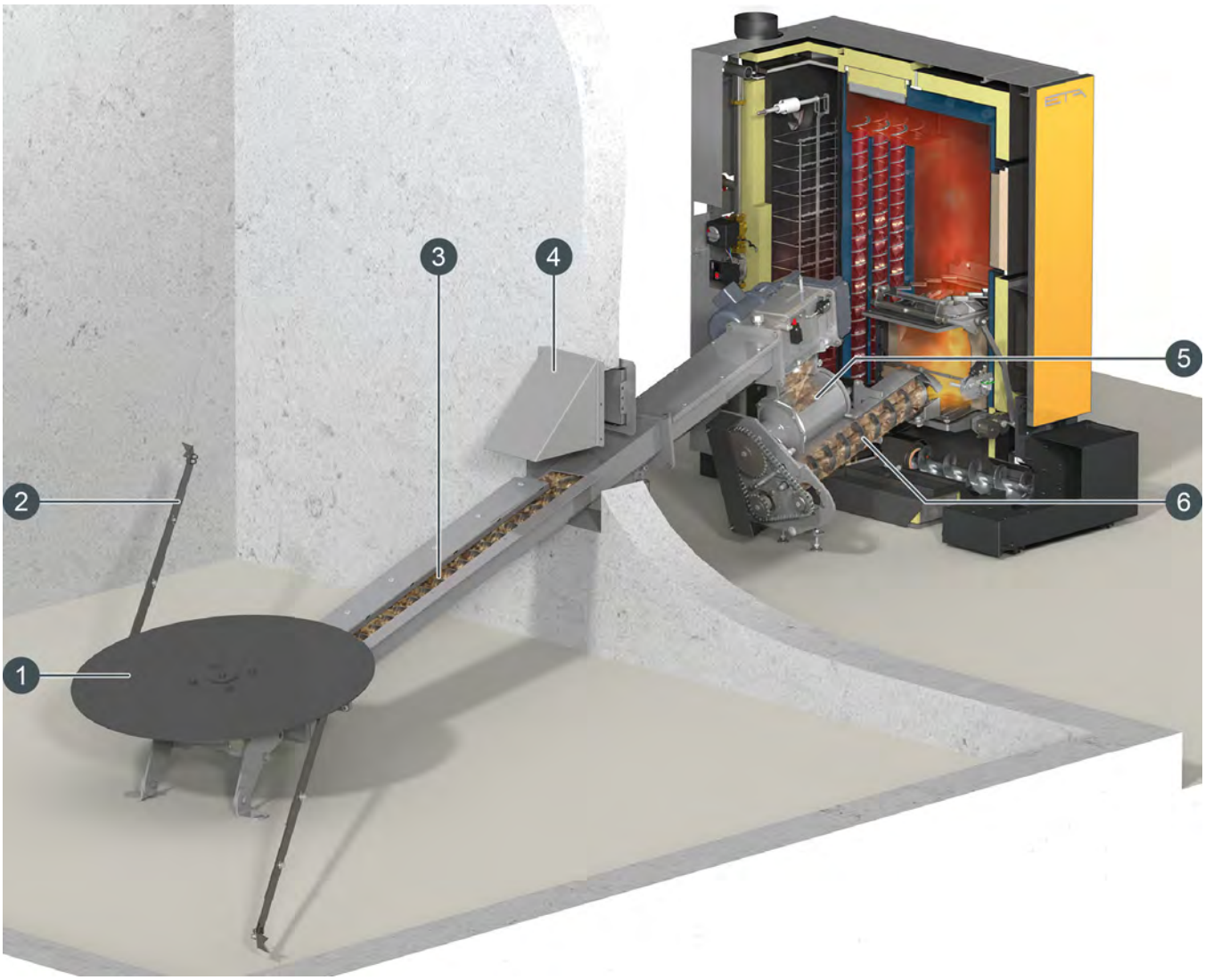
Quick help

Give your installer or the ETA customer service representative temporary access to your meinETA account. So they can prepare for their visit to you. And maybe the technician doesn't even have to come visit, because thanks to meinETA they can tell you over the phone what you need to do to make your heater work again. You can see who can access your boiler via the status display. Only you decide who's in your partner network!

4 Fuel conveyor

4.1 Functional description

Representation of the fuel discharge



1 Agitator plate
2 Flat spring arms
3 Discharge screw
4 Maintenance opening
5 Single chamber rotary valve
6 Stoker screw

Conveying system operation mode

The wood chips are transported to the discharge screw by the floor agitator. The spring arms adjust themselves to the load above them. If the storeroom is full, the floor agitator is subjected to a heavy load and the spring arms are pressed against the agitator plate, reducing the force needed to turn the agitator and thus the electricity consumption. As the storeroom empties, the spring arms extend toward the wall and clear out the storage space.

To prevent the spring arms from being stuck in an extended position under the pile of wood chips, the floor agitator must be turning during filling. Details can be found in chapter 5 "Filling systems".

The power consumption of the motors is monitored so that any sluggishness in the conveyor screws is registered immediately. This triggers the screws to run briefly in reverse, up to three times if necessary. The floor agitator is simultaneously decoupled via the universal joint with one-way clutch, so the motor's power is exclusively available for unblocking the screw. Jammed pieces of wood or even stones can be easily loosened this way so fuel transport can resume.

Patented ETA single-chamber rotary valve

ETA sets new safety standards with the sealed single-chamber rotary valve. In contrast to conventional burn-back flaps, there is never a position that results in a direct connection between the combustion chamber and the fuel store. Dangerous burn-back is excluded, as no hot gas from the combustion chamber can penetrate the fuel feeding system.



Fig. 4-1: ETA single-chamber rotary valve

Benefits of the ETA single-chamber rotary valve:

- Low power and energy requirements even with coarse wood chips
- Long pieces of wood are cut by blades
- Less wear
- Quiet
- Large seal area, and thus maximum burn-back safety

The blade on the rotary valve serves to cut off very long individual pieces of wood chips. A "rotary valve stop" is used to ensure that it doesn't cut wood chips of the proper size. This stops the single chamber rotary valve, so that it is always open at the top prior to fuel being conveyed from the storeroom.

The rotary valve and the discharge screw always operate alternatingly. First, the discharge screw feeds the fuel and only then does the rotary valve rotate. This protects the cutting blade and reduces wear on the sealing edges, thus ensuring a long service life.

Conventional two-chamber or multi-chamber rotary valves have the following characteristics:

- Higher power and energy requirements, especially with coarse wood chips
- Long pieces of wood bring the boiler to a standstill
- Excessive wear
- Noisy
- Small sealing surfaces, and thus less burn-back protection

Universal joint with one-way clutch

The universal joint with one-way clutch ensures that the motor can change direction to loosen blockages in the transport screw, without the floor agitator also rotating in the wrong direction.



Fig. 4-2: Universal joint with one-way clutch

Maintenance opening

In the wall opening between the fuel store and the boiler room, a maintenance opening should be installed above the conveying system's closed trough. It requires an opening of 215x155 mm in the wall.

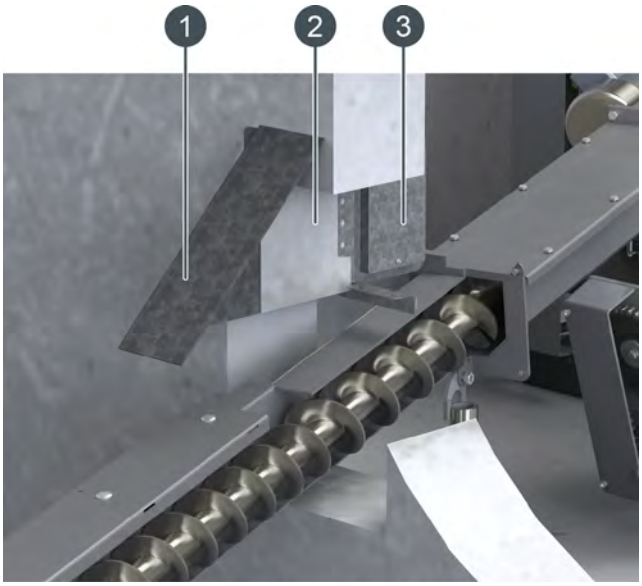


Fig. 4-3: Maintenance opening

1 Storeroom cover
2 Opening in the masonry
3 Maintenance door (fire protection door EI30 required)

4.2 Fuel store

4.2.1 Requirements

General requirements for wood chip storage

- Do not step onto the fuel mound. An increased risk of injury due to bridging and the associated risk of collapse of the fuel mound exists.
- Firefighting equipment must be kept visible and unobstructed.
- The wood chip storage must be protected against weathering (especially rain and moisture). It must be lockable, if possible, in order to prevent unauthorized access (for example: by children playing).
- Irrespective of the discharge systems, the maximum extensions, inclinations and filling heights must be observed, see chapter 4.4.1.1 "Technical data".
- The country-specific building and fire protection regulations must be observed.

Wood chip storage ventilation

For wood chip storages in Austria, a minimum ventilation cross-section of 400 cm² to the outside must be provided (see ÖNORM H 5170).

A protective screen at the air intake opening, however, reduces the free cross section. Therefore, the air inlet opening must be larger, depending on the protection grill. For air ducts through channels, an expert calculation is required.

This value may differ depending on the country-specific standards. Enquire about this with your authorities. If no rules exist, we recommend using the Austrian minimum cross sections as a guide.

4.2.2 Dimensioning

The right solution for any storeroom

In order for a wood chip heater to be planned correctly, the first question is: How will I fill the storeroom? For this reason, we recommend looking at the possibility of pre-filling the storeroom. Because filling can depend on whether existing structures and machines are to be used, or whether reconstruction and acquisitions are planned. A newly erected ground-level storeroom can be filled with a front loader or telescopic loader, and an existing silo with a filling system. Therefore, make an effort to find the most convenient solution for filling the storeroom.

Once the filling method has been clarified, determine the storeroom dimensions. In principle, this should be dimensioned as large as possible, so that less frequent filling is required.

Dimensioning of the storeroom

To dimension the storeroom, the expected fuel consumption must first be determined. This can either be estimated from the boiler output, or from the running hours of the boiler.

Estimation based on boiler output

The formula for this is as follows:

$$V_{srm} = P_k \cdot 2{,}5$$

V_{srm}	...	Volume in loose cubic metres in [m³].
		A loose cubic metre (srm) corresponds to 1 m³ of loosely filled wood chips.
P_k	...	Boiler output in [kW]

Example:
For a boiler with an output of 50 kW and average fuel quality, an annual consumption of approximately 125 cubic metres is expected.

$$V_{srm} = 50 \cdot 2{,}5 = 125\ srm$$

For higher fuel qualities (low contamination, low bark, low water content), this is reduced by a factor of "2". For the above example, the annual consumption is reduced to approx. 100 cubic metres.

Estimation based on running hours

The formula for this is as follows:

$$V_{srm} = \frac{P_k \cdot t_{VLH}}{Hw}$$

V_{srm}	...	Volume in loose cubic metres in [m³]
P_k	...	Boiler output in [kW]
t_{VLH}	...	Maximum permissible full load hours of the boiler per year in [h]. This is stated in the guarantee conditions of the respective boiler.
Hw	...	Calorific value of the fuel in [kWh/srm]

Example:
For a boiler with an output of 50 kW and spruce wood chips of size "P16S" with 30% water content, the resulting annual consumption is about 128 cubic metres.

$$V_{srm} = \frac{50 \cdot 2000}{780} = 128\ srm$$

You can find the heating values of different fuels in chapter 11.7 "Heating value".

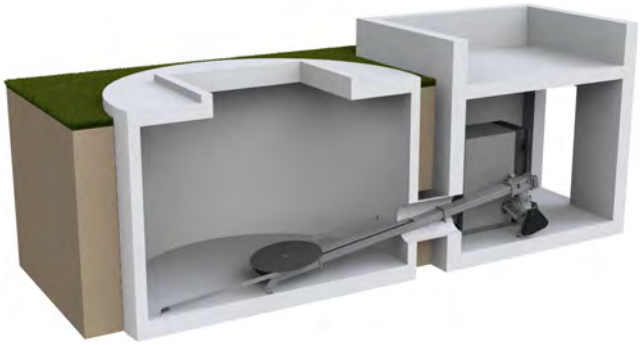
Determining the number of refills

With an agitator with a diameter of 4 m and a maximum filling height of 5 m, a storage volume of about 62.8 m³ (= ((d² x π)/4) x filling height) is achieved.
With an annual consumption of 128 m³, the storeroom must be filled twice per year (128 / 62.8 = 2).

However, if a 6 m diameter agitator is used instead of the 4 m agitator, a storage volume of approx. 141 m³ is obtained at a maximum fill height of 5 m. With a consumption of 128 m³, the storeroom must therefore only be filled once per year.

Floor agitator dimensioning

The rotation of the floor agitator clears a circular area in the storeroom. In a storeroom with corners, a portion of the fuel will always remain unused in the corners. To use all of the fuel, a round storeroom (maximum diameter 6 m) would be preferable.



For a storeroom with, for example, interior dimensions of 4 x 4 m a floor agitator with a diameter of 4 m would usually be used. However, a slightly larger floor agitator with 4.5 m diameter can also be used. With it, the flat spring arms are able to reach the otherwise inaccessible corners of the fuel store and can also clear out the fuel there. This requires planning, because the open trough must be located entirely in the storeroom and should not protrude through the wall.

When there is little fuel in the storeroom, the flat spring arms are relaxed and extend to the inner walls. To avoid damaging the walls, boards should be attached to them at the height of the flat spring arms.

To prevent bridging in the fuel store, the size of the floor agitator should never be smaller than the diameter of the storeroom.

If the storeroom is square, a larger floor agitator can be installed. It is acceptable for the flat spring arms to strike the edge of the storeroom and also convey the fuel there. In order to protect the masonry, wooden panels can be fitted all around, against which the flat spring arms can strike. This also minimizes the risk of bridging. However, it must be noted that the open trough must not be located in the wall. Therefore, the floor agitator is to be offset from the centre. Plans for this are available from ETA.

Maximum fill height

The maximum fill height for wood chips is 5 m (approx. 200 kg/ m³). Due to the greater weight (approx 650 kg/m³) with a floor agitator, pellets can only be filled up to a maximum height of 2 m.

If the fill height is more than twice the diameter of the agitator (e.g. higher than 4 m for an agitator with 2 m diameter), there is a risk of cavitation (also called bridging). This is especially the case with wood chips with a high water content, a lot of fine content or shredded wood chips.

Cavity formation means that the wood chips wedge into each other and no longer slip into the agitator. This creates a cavity above the agitator over time, which is not visible from the outside. This is often only noticed when the boiler outputs an error message because no more wood chips reach the boiler. The remedy here is to poke in the wood chips with, e.g. rods, so that the hollow space collapses.

For this reason it is forbidden to enter the wood chip store, especially the area above the agitator, because there is a danger of collapse due to the formation of cavities and thus an increased risk of injury.

4.2.3 Tilted floor

Slanted floor for the fuel

With a slanted floor in the storeroom, the fuel cannot get under the floor agitator, so there is no unused space. Without the slanted floor, the space under the flat spring arms is filled first when filling the fuel store. This volume is not accessible to the flat spring arms and remains unused and over time the material there will decay.



Fig. 4-4: Slanted floor

Benefits of the slanted floor:

- The flat spring arms move along the floor and cannot "float" over the fuel.
- The fuel is not compacted in the outer area of the floor.

However, some points have to be considered when building a slanted floor:

- The static load upon the substructure must be considered.
- A slanted floor is required for operation with pellets.
- For the cavity below the slanted floor, sufficient ventilation must be provided so that moisture can escape. Country-specific regulations are to be observed.
- The cavity under the slanted floor forms a resonating body. As a result, sound transmissions can be generated throughout the residential building or adjacent structures.

  If the fuel storage is located in a residential building or adjacent to one, a slanted floor is not recommended.

If no slanted floor is installed, the first filling of the storeroom must be performed with dry wood chips. Because these remain lying on the floor and later form the support for other fillings. In contrast, moist wood chips would slowly rot, thus reducing the gross calorific value of later fillings.

Slanted floor for floor agitator

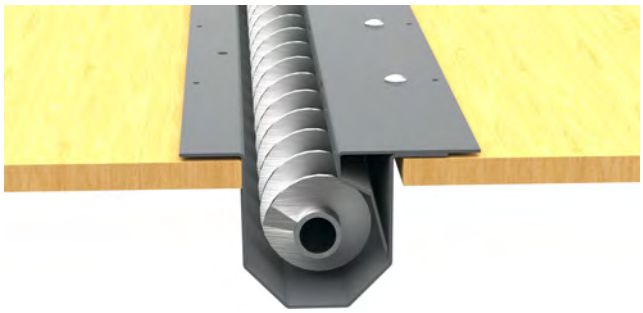


Fig. 4-5: Slanted floor size 1

For size 2 floor agitators, a 45° chamfer needs to be built into the slanted floor at the open trough. Otherwise, too little fuel will reach the screw conveyor.

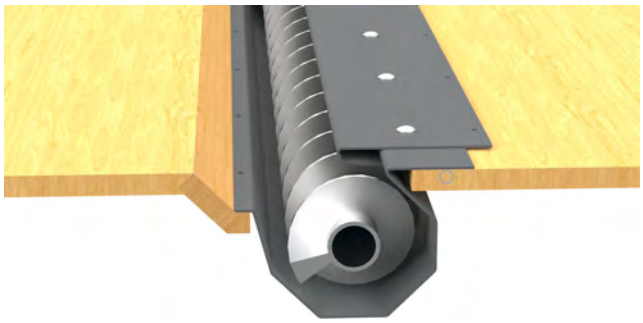


Fig. 4-6: 45° chamfer floor agitator size 2

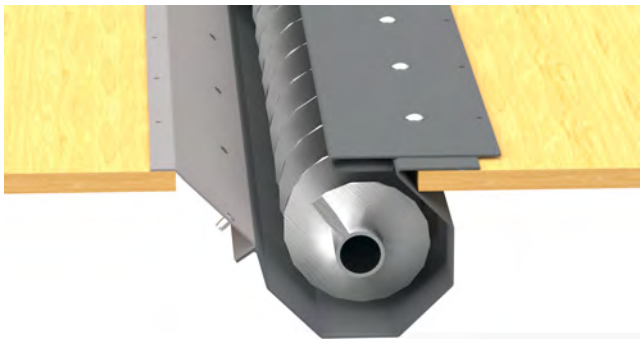


Fig. 4-7: Slanted floor size 2.5 / size 3

4.3 Pellet operation

Wood chip boiler with pellet operation

If there is little space for a wood chip store, pellets are the ideal solution, as the energy density of pellets is about four times as high as that of wood chips. So for the same heat output you only need a quarter of the storeroom.

A boiler with an output of 45 kW requires approximately 15 tons of pellets per year, which corresponds to a storage space size of 23 m³. For annual filling, a storeroom volume of just 30 m³ including a pellet reserve is sufficient.

For the fuel discharge, either an agitator or a pellet discharge screw can be used.

Special requirements apply to pellet storage rooms. For more information, please contact ETA.

Floor agitator for pellets

For pellet operation with a floor agitator, the following points must be observed:

- Pellets are much heavier than wood chips. Which is why floor agitators may only be filled with pellets up to a height of 2 metres.
- To ensure that the pellets are not damaged, only floor agitators up to a maximum of 4 metres in diameter may be used, and the angle of inclination may not exceed 12°.
- A special cover plate for pellets is needed on the open trough screw in the store to prevent overfilling of the discharge screw.
- The trough screw between store outlet and boiler may be a maximum of 1.5 metres long.



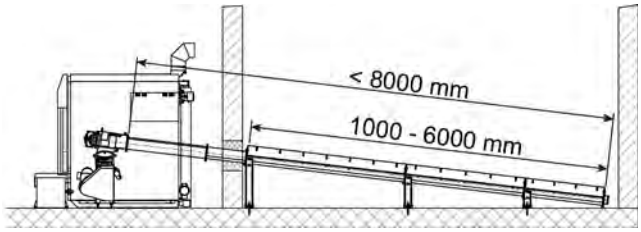
Fig. 4-8: Floor agitator for pellets

Pellet discharge screw

If the boiler is operated exclusively with pellets, then a pellet discharge screw is the better solution. This is due to the fact that more pellets can be filled with this solution. Please note that the screw must be routed to the boiler for this conveying system. The maximum fill height for a pellet discharge screw is 7 m.



Fig. 4-9: Discharge screw for pellets



4.4 Conveying system variants

4.4.1 Standard floor agitator

Storeroom on the same level as the boiler

The maximum length between the storeroom outlet and the boiler (L) is 6 m. Small height differences between the boiler and conveying system are compensated by the adjustable inclination of the conveying system.

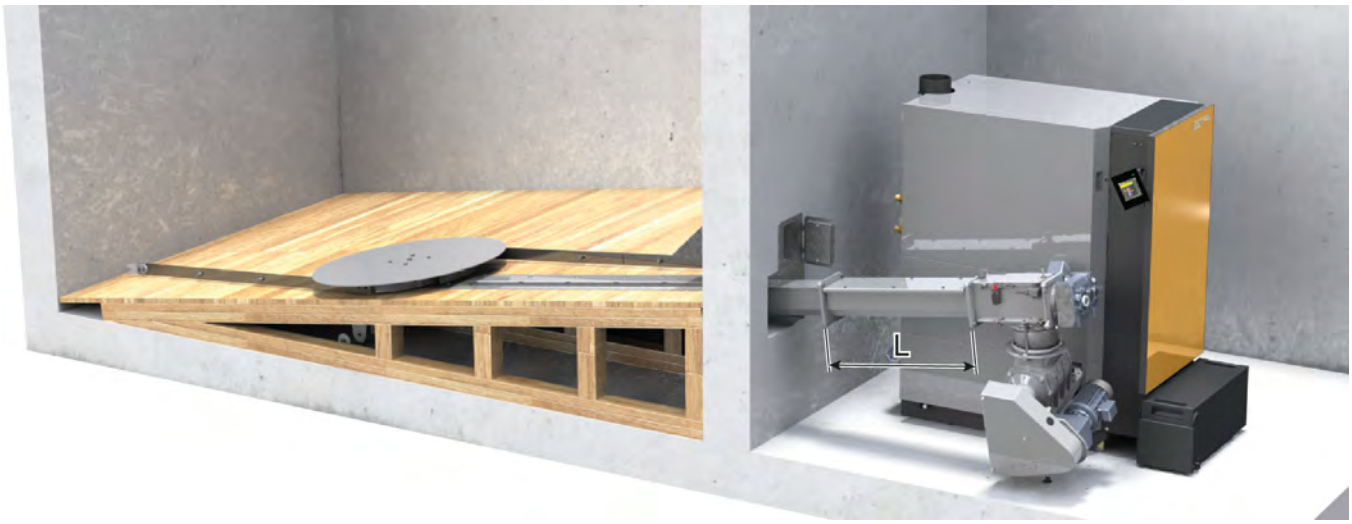


Fig. 4-10: Conveying system with slanted floor

A slanted floor is not always necessary, but a small portion of the storeroom cannot be emptied automatically without a slanted floor. Therefore, the first filling must be carried out with very dry wood chips. Because these remain on the floor and later form the support for other fillings.

For horizontal discharge, a height difference (A) between the store room and the boiler room is required, see table Tab. 4-1: "Height difference "A"". The "ramp" (30-50 cm in height) in front of the floor agitator serves as a collision protection device around the agitator during filling.

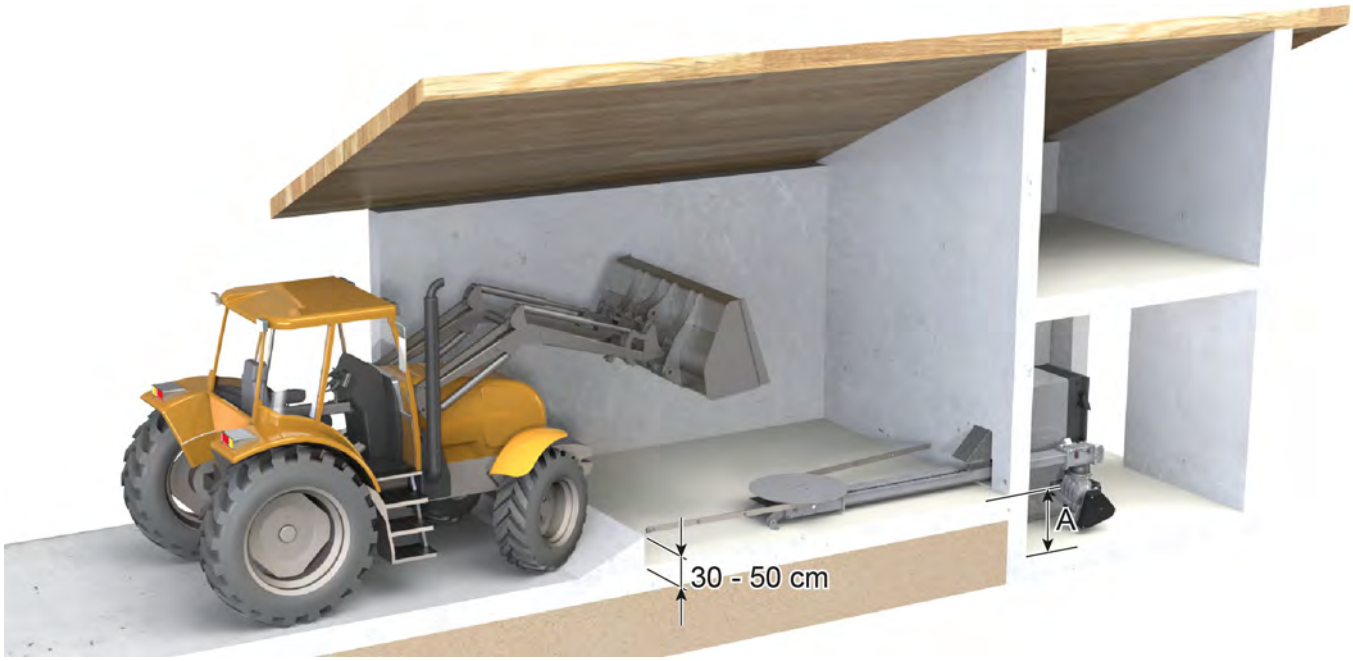


Fig. 4-11: Height difference between store room and boiler room

boiler	Height difference "A"
eHACK 20 - 240 kW	690 mm
HACK VR 250 kW	830 mm
HACK VR 333 - 500 kW	900 mm

Tab. 4-1: Height difference "A"

As an alternative to a slanted floor, the floor agitator can also be "sunk" into the ground. The dimensions of the recess are given in the following chart. The height (H) of the recess depends on the size of the conveying system.

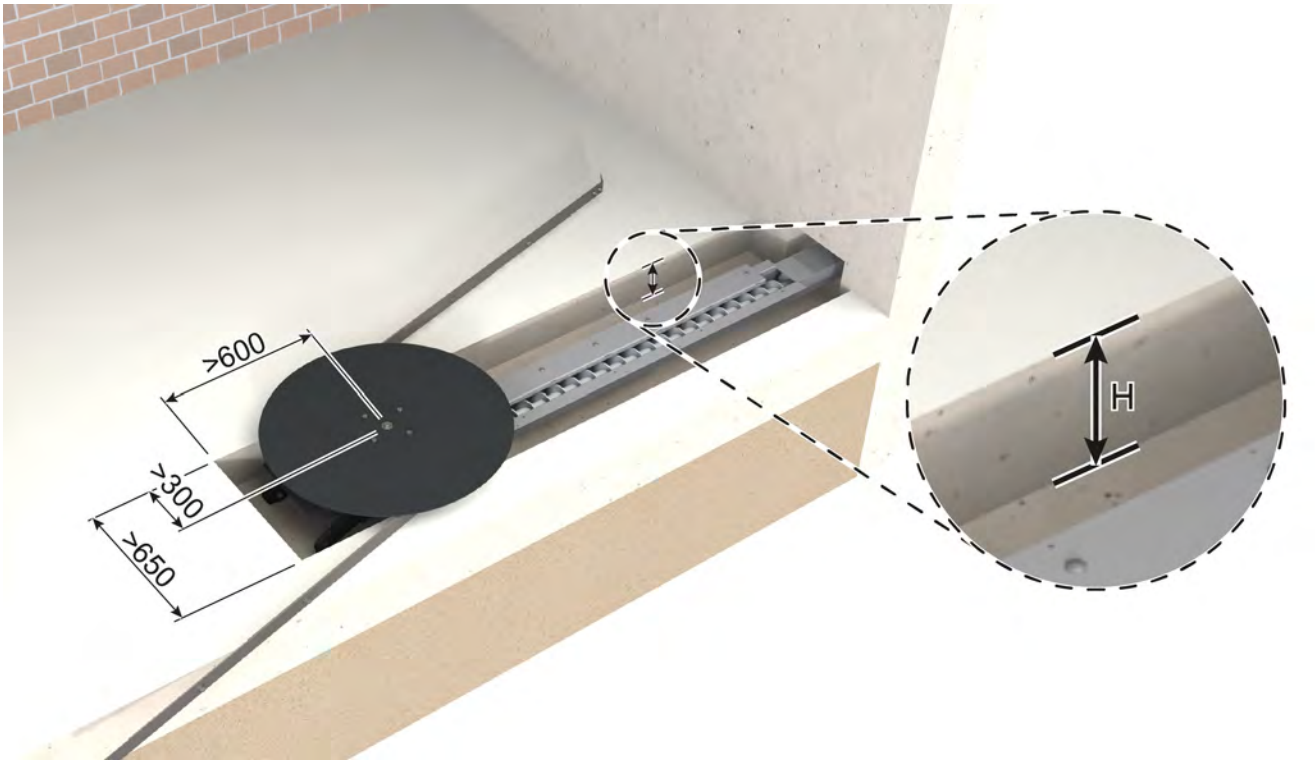


Fig. 4-12: Sunken floor agitator

Size (BG) of the conveying system	Recess height "H"
BG 1	185 mm
BG 2	230 mm
BG 2.5	250 mm
BG 3	290 mm

Tab. 4-2: Recess height

The size of the conveying system and the compatible boilers can be found in chapter 4.4.1.1 "Technical data".

Underground storeroom

The central ceiling opening above the floor agitator allows quick and easy filling through a shaft. A pre-existing silo or room can be used, thus reducing the required construction effort.

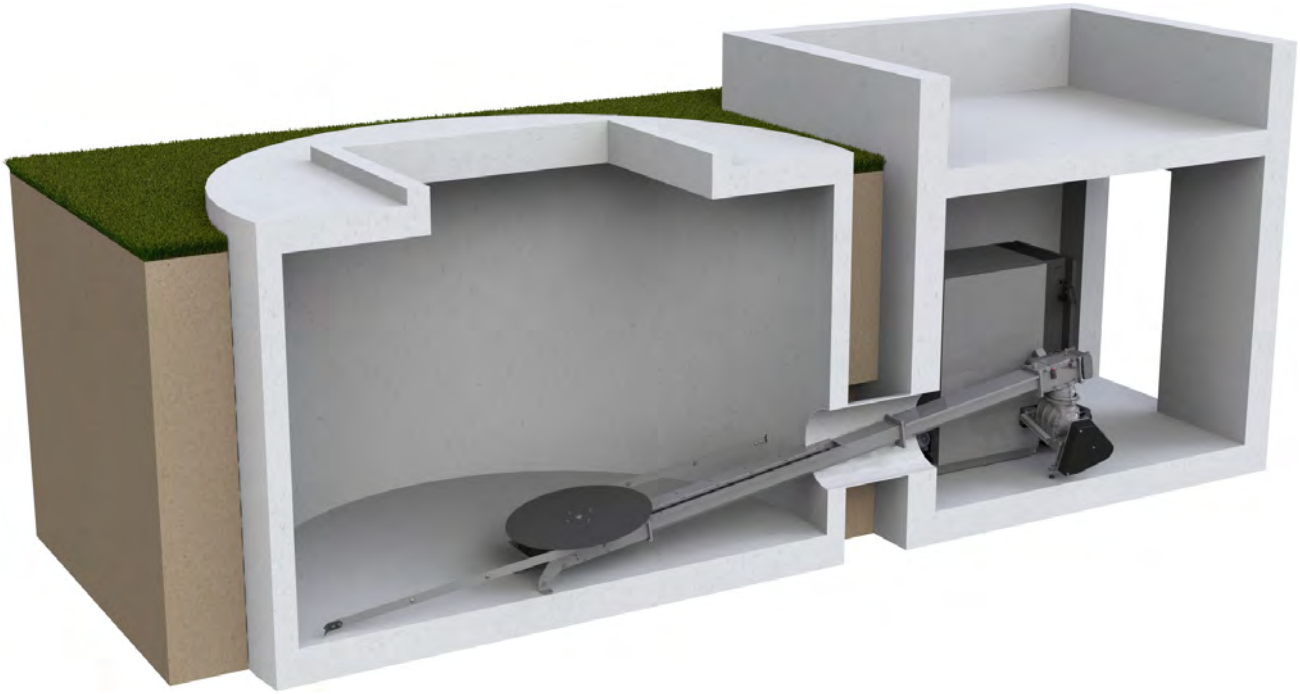


Fig. 4-13: Underground storeroom

The filling opening or recess in the ceiling must be designed large enough and centrally positioned above the floor agitator so that the storeroom can be filled fully. The maximum filling height must be observed, see chapter 4.4.1.1 "Technical data".

The cover for the filling opening must provide for adequate ventilation for the storeroom and also protect it from weather influences (e.g. rain). For safety reasons, the cover should be lockable (due to risk of injury from an open shaft).

4.4.1.1 Technical data

Maximum lengths and inclines

Below you will find the information on the maximum lengths and inclinations for conveying systems of different sizes.

If deviations from the stated values are necessary, please consult ETA Heiztechnik GmbH.

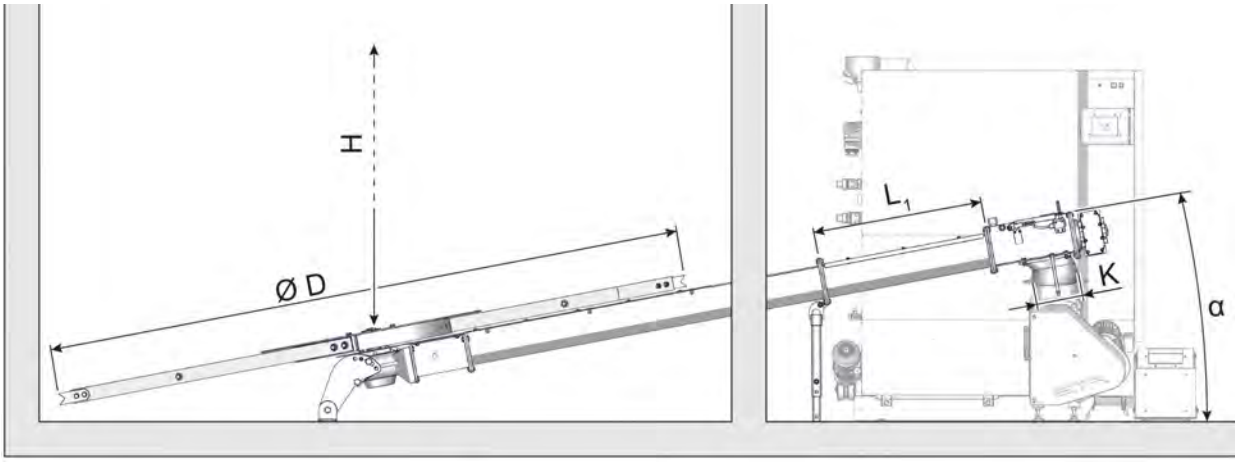


Fig. 4-14: Side view

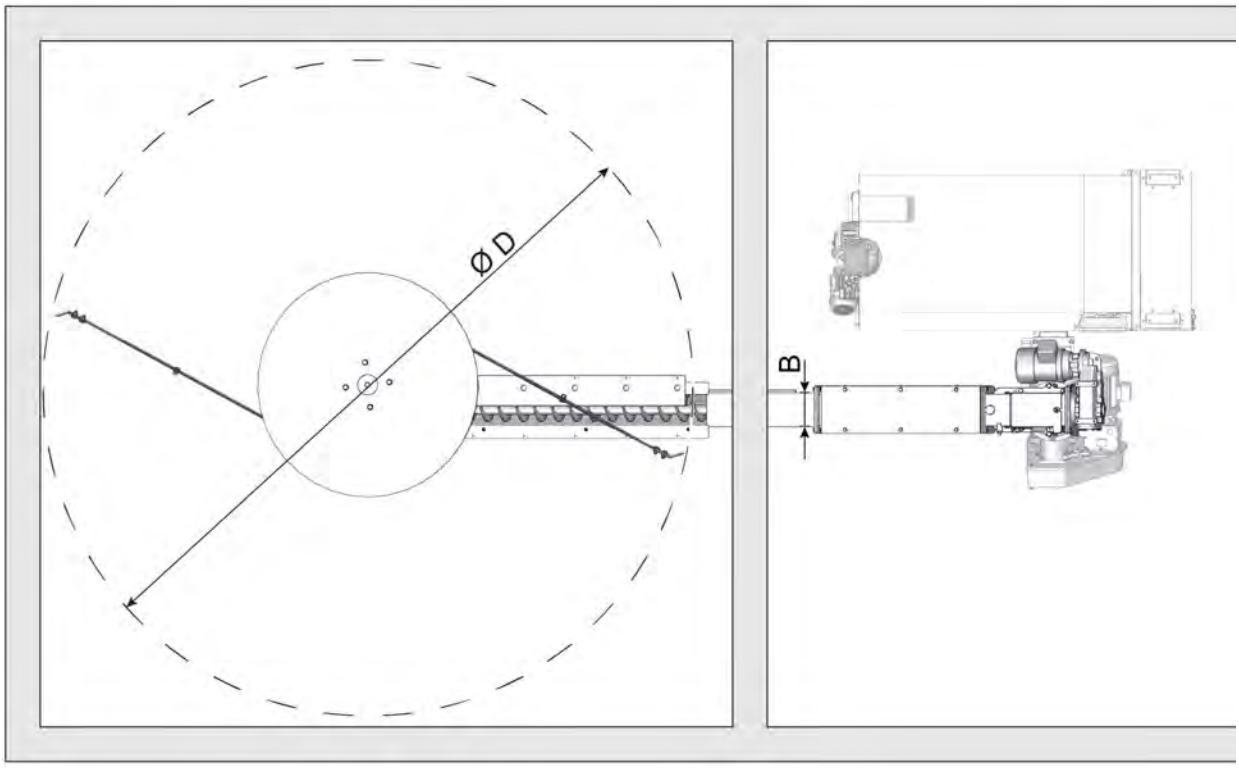


Fig. 4-15: Top view

Discharge	Unit	BG 1	BG 2		BG 2.5	BG 3
Trough - width B	mm	140	190			230
Ball joint - diameter K	mm	200			250	
compatible boilers:						
eHACK	kW	20 - 80	100 - 170	180 - 240		
HACK VR	kW	-	-	250	333 - 350	500

Agitator for wood chips

Discharge	Unit	BG 1	BG 2		BG 2.5	BG 3
Floor agitator - Diameter D and drive power:						
with leaf spring arm	m	1.5 - 4	3 - 4			
	kW	0.37	0.55	1.1		1.5
with articulated arm	m	4.5 - 5				
	kW	0.55		1.1		1.5
with double articulated arm	m	5.5 - 6				
	kW	0.55		1.1		1.5
closed trough:						
Total length L_1	m	< 6				
Inclination α		< 15°				
Fill height H	m	< 5				
Number of spring arms		2				

Deviations from these specifications are only possible in consultation with ETA Heiztechnik GmbH.

Agitator for pellets

Discharge	Unit	BG 1		BG 2		BG 2.5	BG 3
Floor agitator - Diameter D and drive power:							
with leaf spring arm	m	2	2.5 - 4	3 - 4			
	kW	0.37		0.55	1.1		1.5
closed trough:							
Total length L_1	m	< 2.5					
Inclination α		< 12°					
Fill height H	m	< 2					
Number of spring arms		2	4				

For pellet operation, a conversion kit is required for the floor agitator and trough.

4.4.2 Twin screw agitator

Twin screw agitator, an agitator with two conveyor screws

This can simultaneously supply two boilers with fuel. As a result, both boilers can be operated simultaneously, enabling an optimal load coverage. Agitator diameters from 3 m to 6 m are possible.

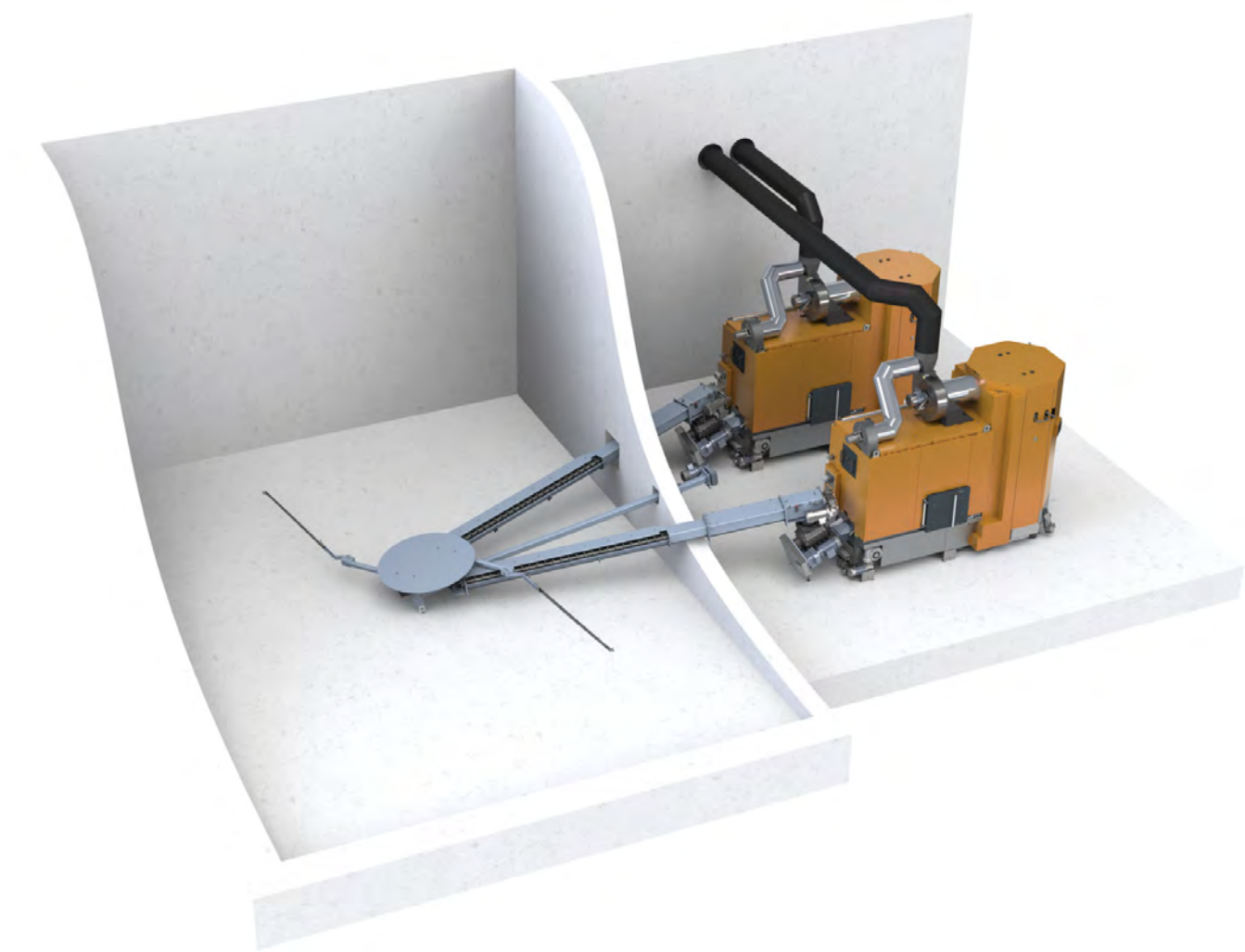


Fig. 4-16: Twin screw agitator

The twin-screw agitator is designed for a maximum output of 700 kW.

4.4.2.1 Technical data

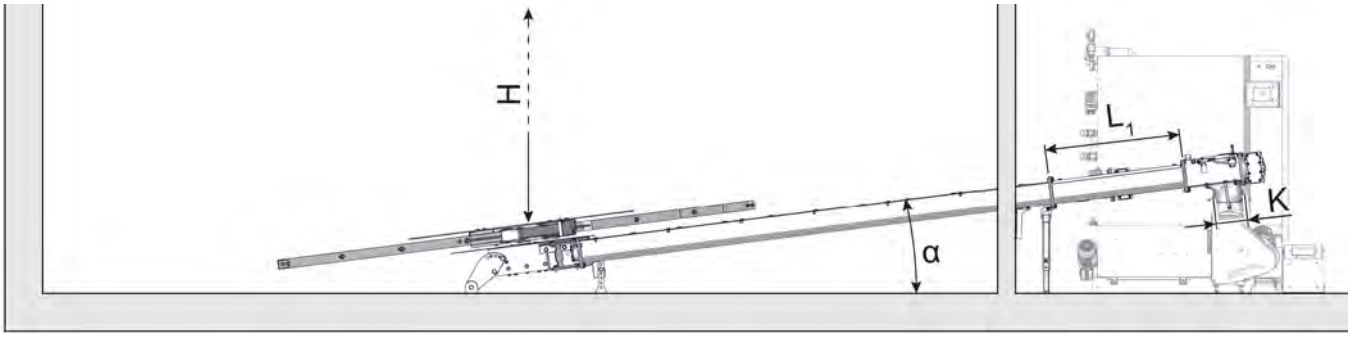


Fig. 4-17: Side view

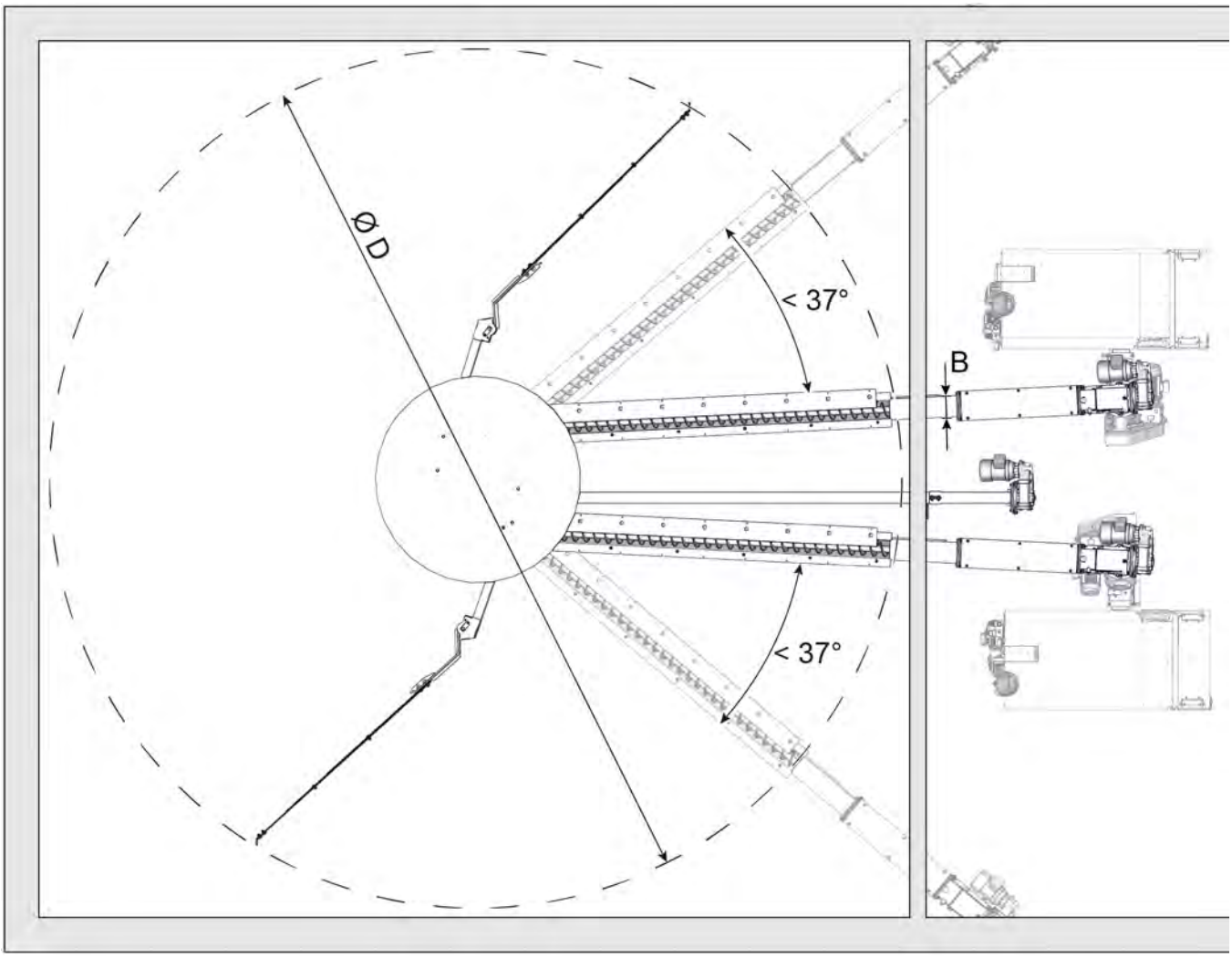


Fig. 4-18: Top view

Twin Screw Agitator

Discharge	Unit	BG 1	BG 2	BG 2.5
Compatible boilers	kW	20 - 90	89 - 220	250 - 350
Boiler cascade - maximum output	kW		< 700	
Trough - width W	mm	140	190	190
Ball joint - diameter K	mm	200	200	200 / 250

Agitator for wood chips

Discharge	Unit	BG 1	BG 2	BG 2.5
closed trough - total length L_1	m		< 6	
Floor agitator - diameter and drive power:				
with leaf spring arm	m	3 - 4	3 - 4	4
	kW	3 x 0.37	3 x 0.37	1 x 0.37
	kW	-	-	2 x 1.1
with articulated arm	m	4.5 - 5	4.5 - 5	4.5 - 5
	kW	2 x 0.37	2 x 0.37	1 x 0.55
	kW	1 x 0.55	1 x 0.55	2 x 1.1
with double articulated arm	m	5.5 - 6	5.5 - 6	5.5 - 6
	kW	2 x 0.37	2 x 0.37	1 x 0.55
	kW	1 x 0.55	1 x 0.55	2 x 1.1
Number of spring arms			2	
Fill height H	m		< 5	
Inclination α			< 15°	

Deviations from these specifications are only possible in consultation with ETA Heiztechnik GmbH.

Agitator for pellets

Discharge	Unit	BG 1	BG 2	BG 2.5
closed trough - total length L_1	m		< 1.5	
Floor agitator - Diameter D and drive power:				
with leaf spring arm	m	3 - 4	3 - 4	4
	kW	3 x 0.37	3 x 0.37	1 x 0.37
	kW	-	-	2 x 1.1
Number of spring arms			4	
Fill height H	m		< 2	
Inclination α			< 12°	

For pellet operation, an optional conversion kit for the floor agitator and the troughs is required.

4.4.3 Double agitator

Double agitator, 2 agitators supply fuel to one boiler

Both agitators alternatingly supply the boiler with fuel. Temporary operation with only one agitator is also possible. Existing elongated spaces can be used, which means that larger storage volumes are possible.

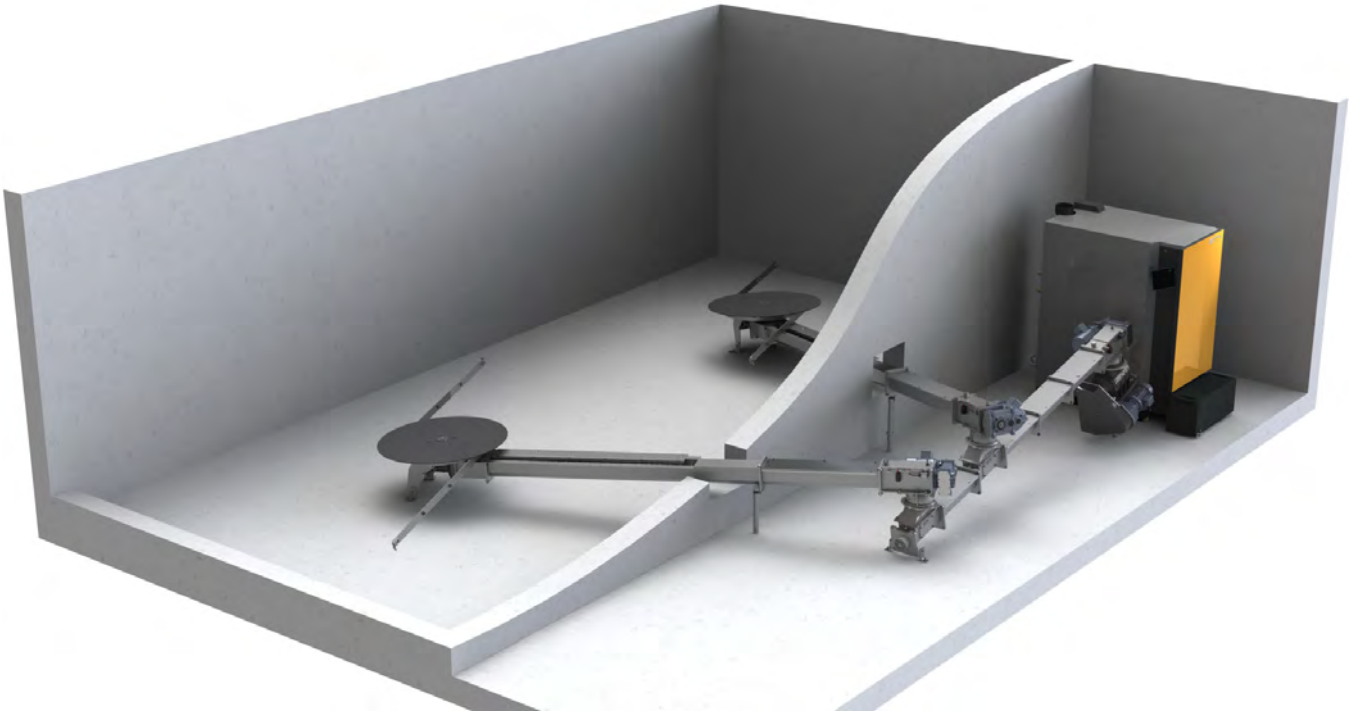


Fig. 4-19: Double agitator

4.4.4 Push floor

Push floor

Characteristics:

- Quick filling is possible due to the accessibility of the push floor.
- The rectangular design ensures optimal space utilization. Thus, large storage volumes can be achieved. Moreover, bridging of the fuel mound is minimized.
- The maximum possible pushrod width is 2 m, whereby a maximum of three push rods can be used next to one another. The maximum fill height is 5 m.
- Only the lower layer of the fuel is moved, so the fuel cannot become segregated.
- The pushrods of the push floor move only when the transverse conveyor screw is empty. This results in lower energy consumption.

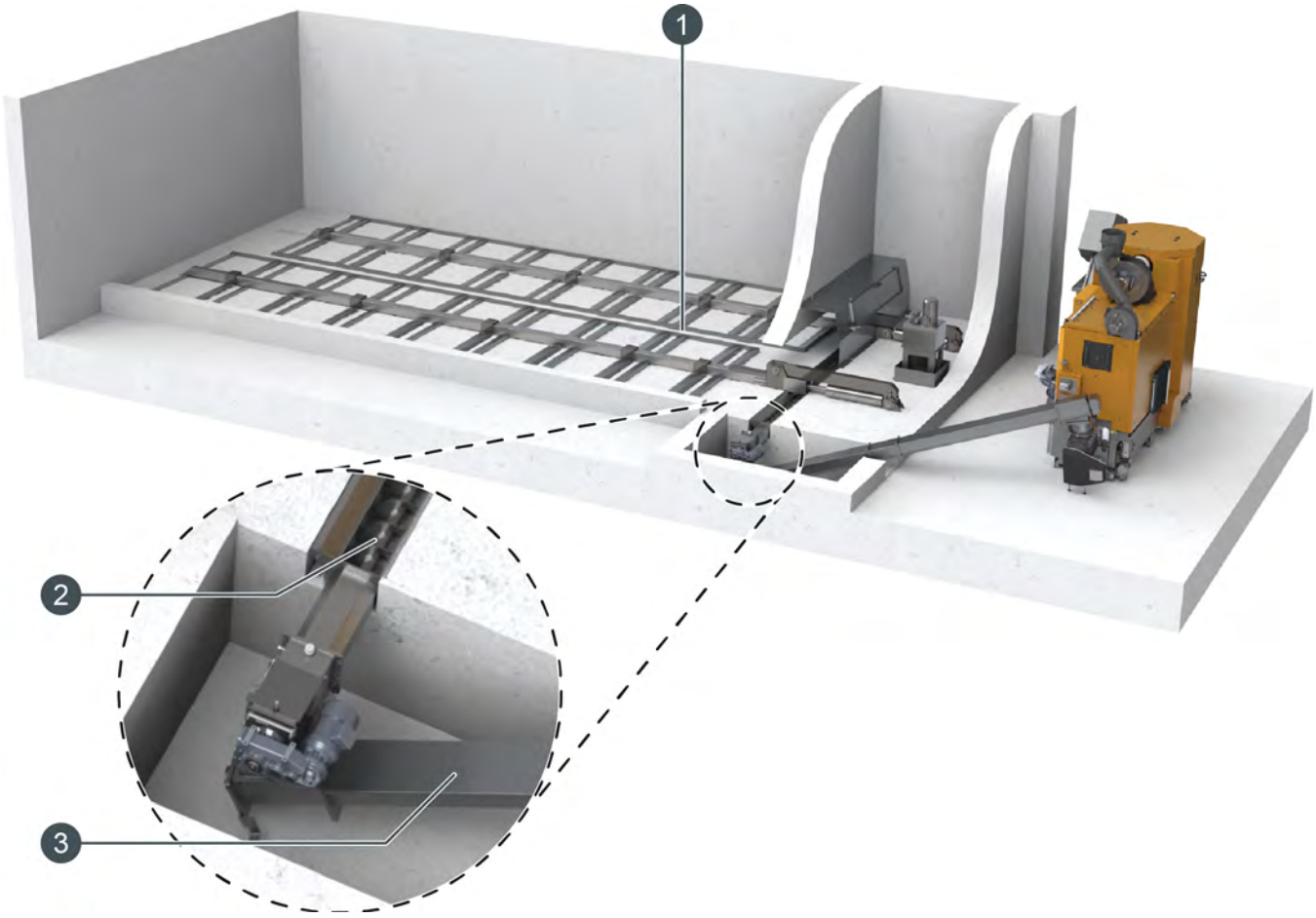


Fig. 4-20: Push floor

1 Push floor
2 Cross conveyor screw
3 Dosing screw

4.4.5 Pivot auger

Pivot auger

This conveying system is ideal for silos positioned above the boiler room or for free-flowing fuel. This conveying system is preferably used in carpentry operations for wood residues. The maximum possible diameter is 6 m, the maximum fill height is 8 m. The risk of bridging is minimized because the pivot auger discharges the fuel across the entire floor surface.

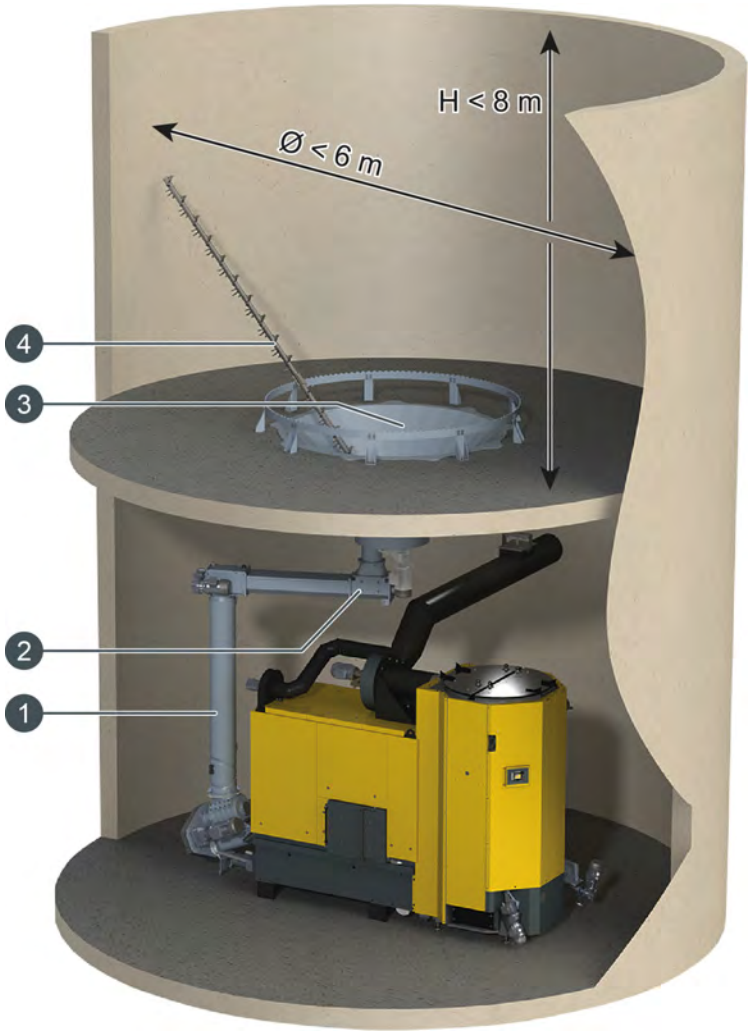
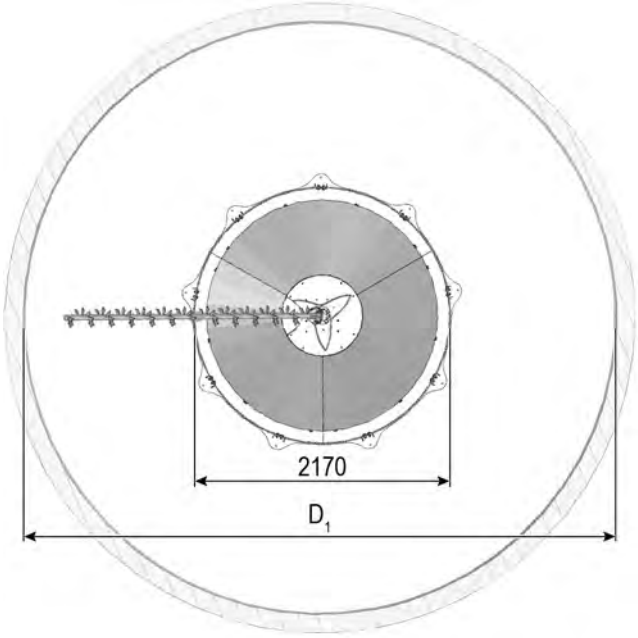


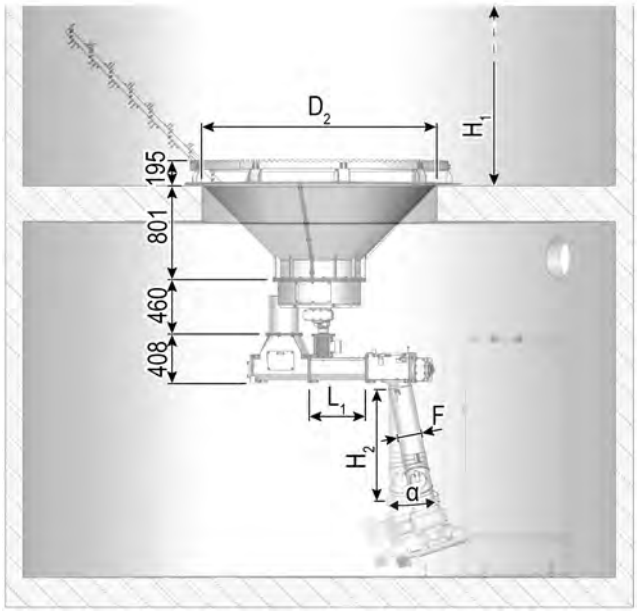
Fig. 4-21: Pivot auger

1 Downpipe
2 Intermediate conveyor screw
3 Funnel with rim. A perforation or opening with a diameter of approximately 2 m is required.
4 Pivot auger

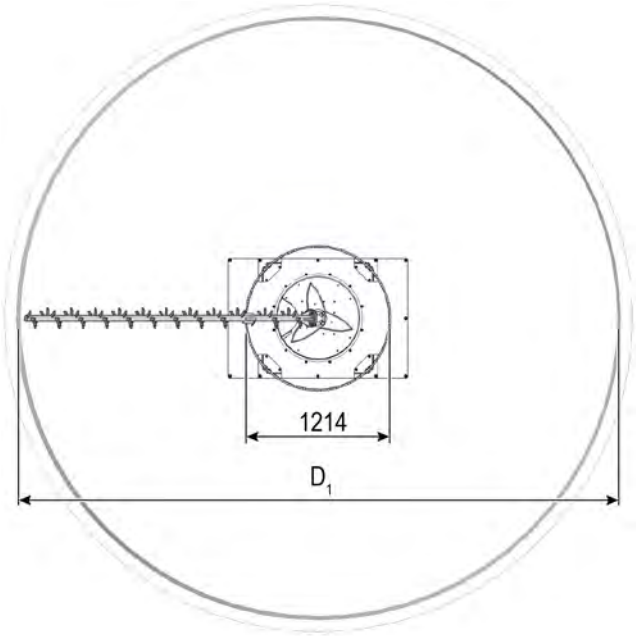
4.4.5.1 Technical data

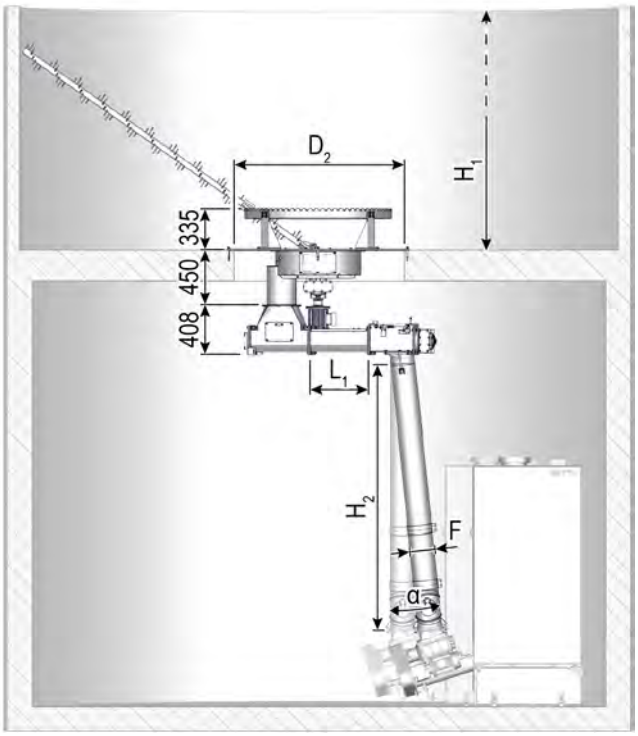
Pivot auger with funnel and an outlet





Pivot auger with collar and an outlet





Discharge	Unit	BG 2			BG 2.5	BG 3
compatible boilers:						
eHACK	kW	20 - 80	100 - 170	180 - 240		
HACK VR	kW			250	333 - 350	500
Pivot auger:						
Drive power	kW	1.5				
Dosing screw:						
Drive power	kW	0.37		1.1		1.5
Trough width	mm	190				230
Length L_1:						
Woodchips	m	0.25 - 8				
Pellets	m	0.5 - 3				-
Downpipe:						
Diameter F	mm	200			250	
Length H_2	m	< 4				
Inclination α		< 12°				

System related data

Pivot auger with funnel	Unit	one boiler	two boilers
Number of outlets		1	2
Ceiling opening diameter D_2	mm	2000 - 2050	
Fuel fill height H_1			
Woodchips	m	1.5 x D_1	
Pellets	m	2	-
Room diameter D_1	m	≤ 6	

Pivot auger with collar	Unit	one boiler	two boilers
Number of outlets		1	2
Ceiling opening dimensions D_2	mm	900 x 900 to 950 x 950	900 x 1400 ±20
Fuel fill height H_1			
Woodchips	m	1.5 x D_1	
Pellets	m	5	-
Room diameter D_1	m	≤ 5	

Deviations from these specifications are only possible in consultation with ETA Heiztechnik GmbH.

4.4.6 Agitator with central outlet

Agitator with central outlet

This conveying system is often used for pneumatically and mechanically loaded storerooms positioned just above the boiler room. Agitator diameters from 3 m to 6 m are possible. However, this agitator is not suitable for operation with pellets. Because the pellets continue to trickle over and thus overfill the rotary valve. A remedy is provided by a separate intermediate conveyor screw after the downpipe up to the rotary valve.

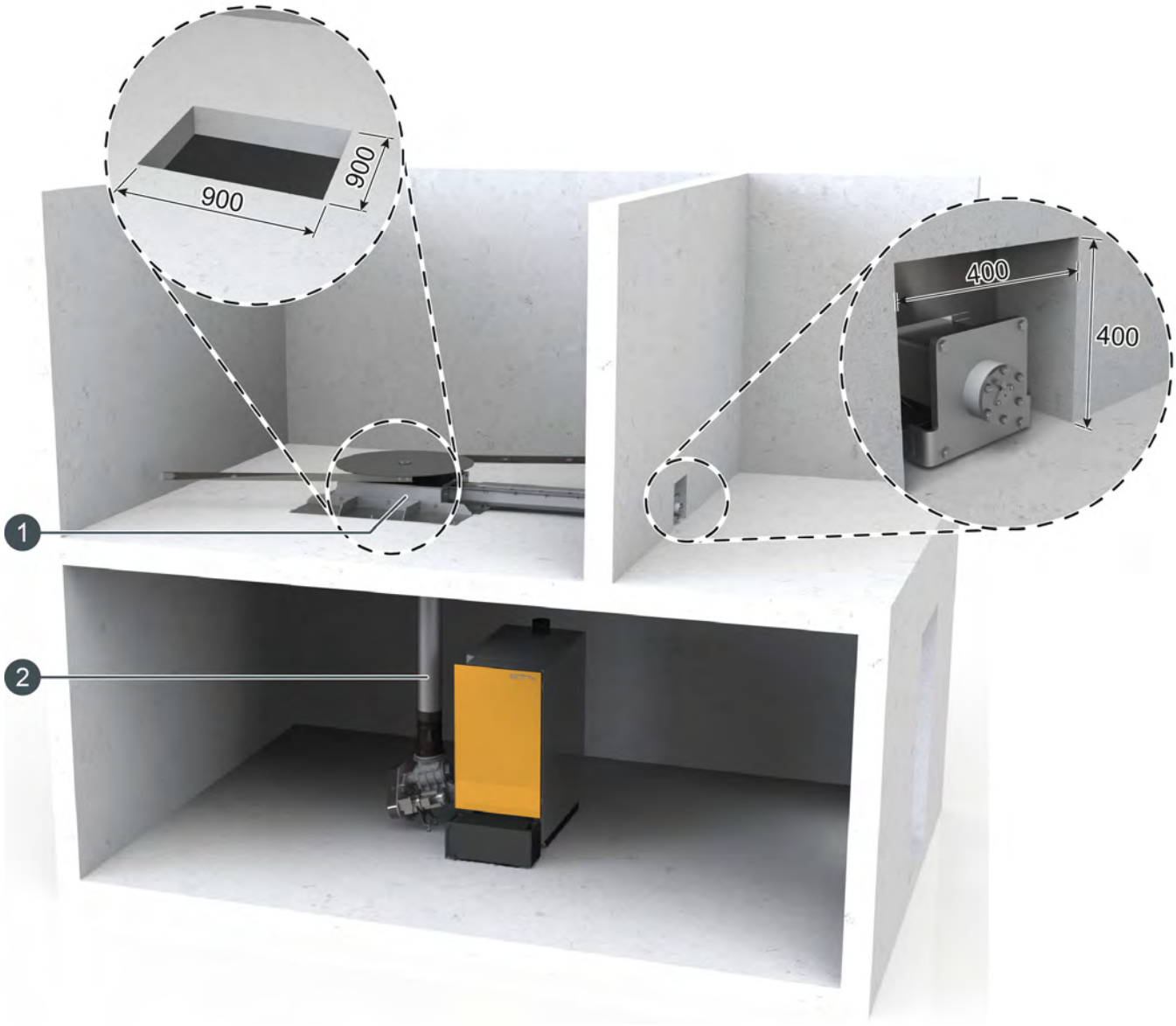
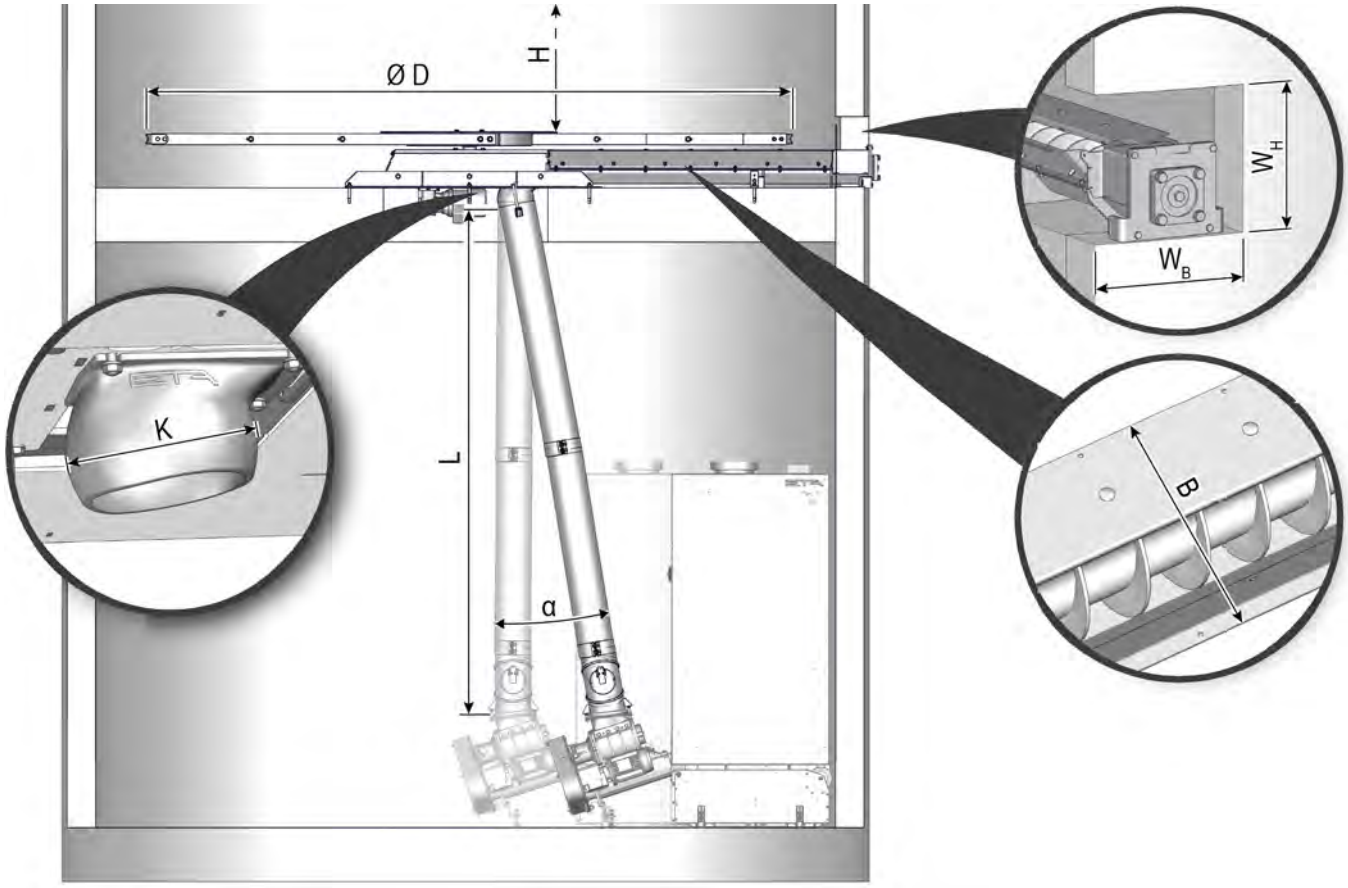


Fig. 4-22: Agitator with central outlet

1 Agitator with central outlet
2 Downpipe

4.4.6.1 Technical data



Discharge	Unit	BG 1	BG 2		BG 2.5
Trough - width W	mm	140	190		
Universal joint - diameter K	mm	200			250
compatible boilers:					
eHACK	kW	20 - 80	100 - 170	180 - 240	
HACK VR	kW		250		333 - 350
Downpipe length L	m	< 4			
Wall maintenance opening W_H x W_W	mm	300 x 250	350 x 300		
Ceiling opening	mm	900 x 900			

Floor agitator in wood chip operation

Discharge	Unit	BG 1	BG 2		BG 2.5
Floor agitator - Diameter D and drive power:					
with leaf spring arm	m	3 - 4			
	kW	0.37	0.55	1.1	
with articulated arm	m	4.5 - 5			
	kW	0.55		1.1	
with double articulated arm	m	5.5 - 6			
	kW	0.55		1.1	
Fill height H	m	< 5			
Agitating arms - quantity		2			

Floor agitator in pellet operation

Discharge	Unit	BG 1	BG 2		BG 2.5
Floor agitator - Diameter D and drive power:					
with leaf spring arm	m	3 - 4			
	kW	0.37	0.55	1.1	
Fill height H	m	< 2			
Agitating arms - quantity		4			

For pellet operation, a conversion kit is required for the floor agitator and trough. Deviations from these specifications are only possible in consultation with ETA Heiztechnik GmbH.

4.4.7 Intermediate container

Intermediate container

Intermediate containers are used, for example, in order to combine an existing conveying system (third-party conveying system) with an ETA boiler. In this case, the third-party conveying system delivers the fuel into the intermediate container. Its fill quantity is controlled via light barriers. There is a separate drive below the intermediate container for the internal agitator. The conveyor screws that remove the fuel from the intermediate container are supplied and controlled by the relevant boiler. Up to three boilers can be connected to an intermediate container.

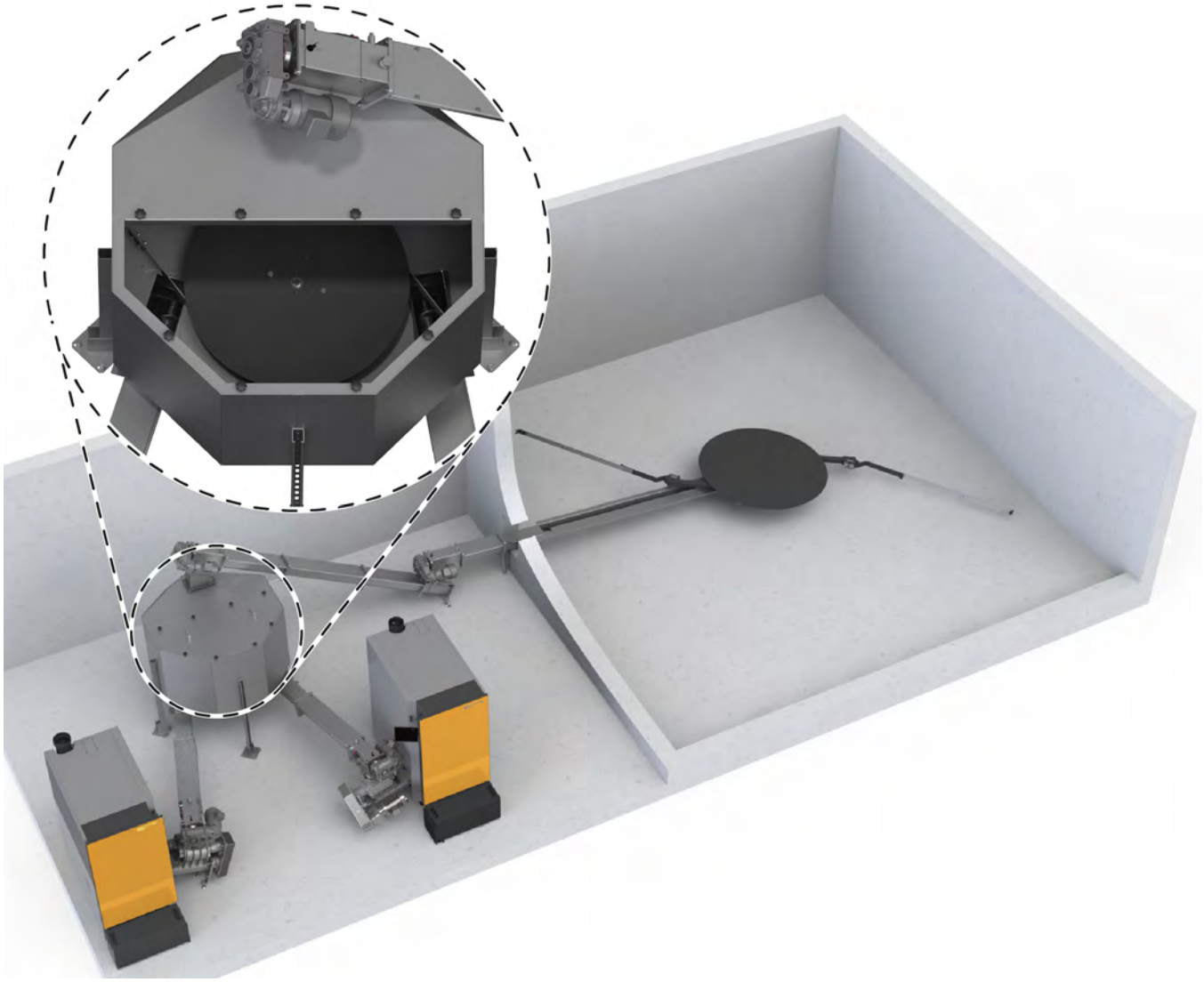


Fig. 4-23: Floor agitator with intermediate container

Other versions are also possible for filling the intermediate container. For further details, please contact ETA Heiztechnik GmbH.

5 Filling systems

5.1 Filling screw

Filling screw

This solution is ideal for using existing rooms as storerooms. Filling can be carried out via a window or a shaft. The filling screw is available in two versions, either with a trough in the filling hopper or without a trough. If possible, the design with trough should be favoured, because in this version the fuel is not pushed away laterally.

The filling screw can be installed horizontally or at a rising angle. The screw helix should always end above the agitator, so that the storeroom can be optimally filled.

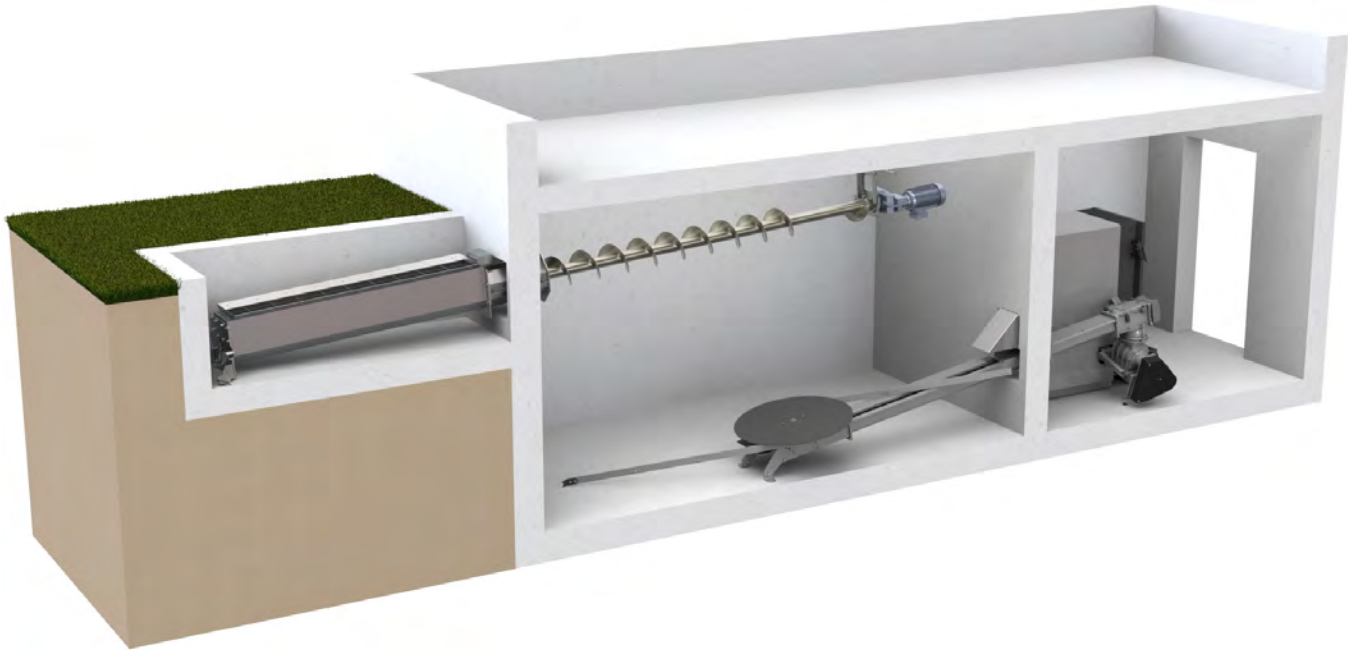
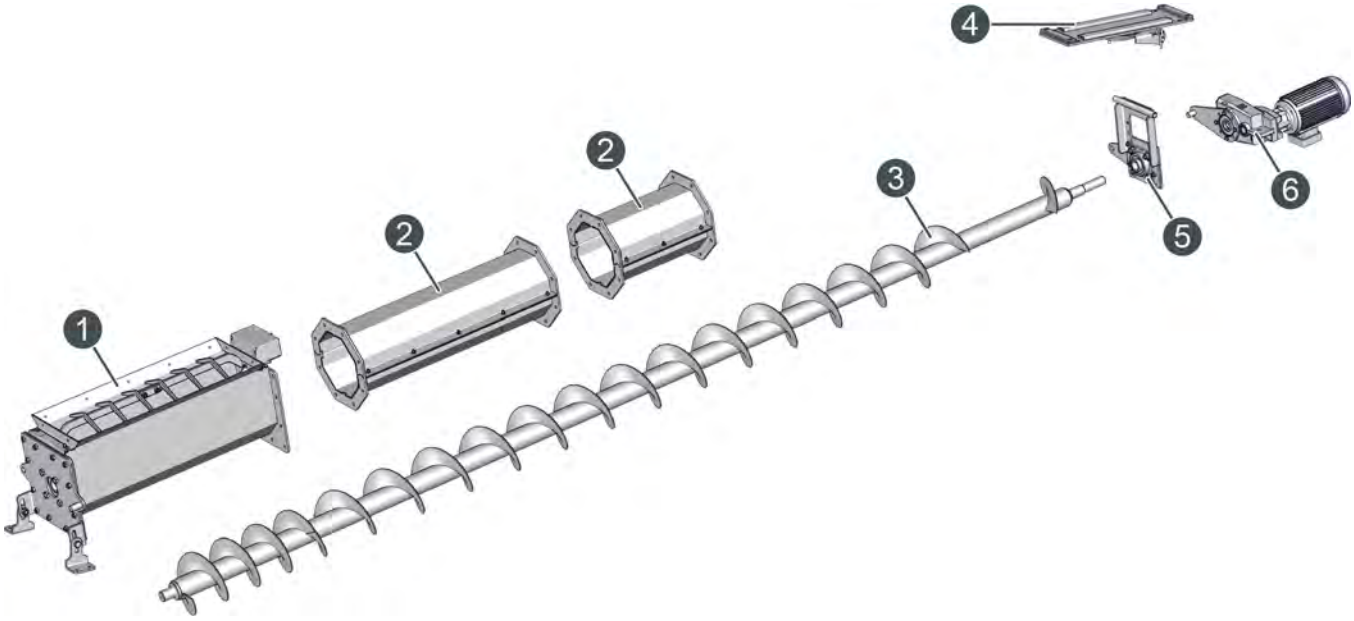


Fig. 5-1: Filling screw with trough

Version	without trough	with trough
maximum total length	6 m	12 m
of which trough =	---	7.5 m
of which storeroom =	4 m	4 m
maximum incline	20°	45° with 8-sided trough

5.1.1 Filling screw with trough

Design of the filling system



1 Open trough with jogging motor (not accessible) and bearing for conveyor screw
2 Closed troughs
3 Conveyor screw (from 6 m in length, two-part)
4 Ceiling attachment
5 Bearing plate for conveyor screw
6 Drive motor with gearbox

Installation details

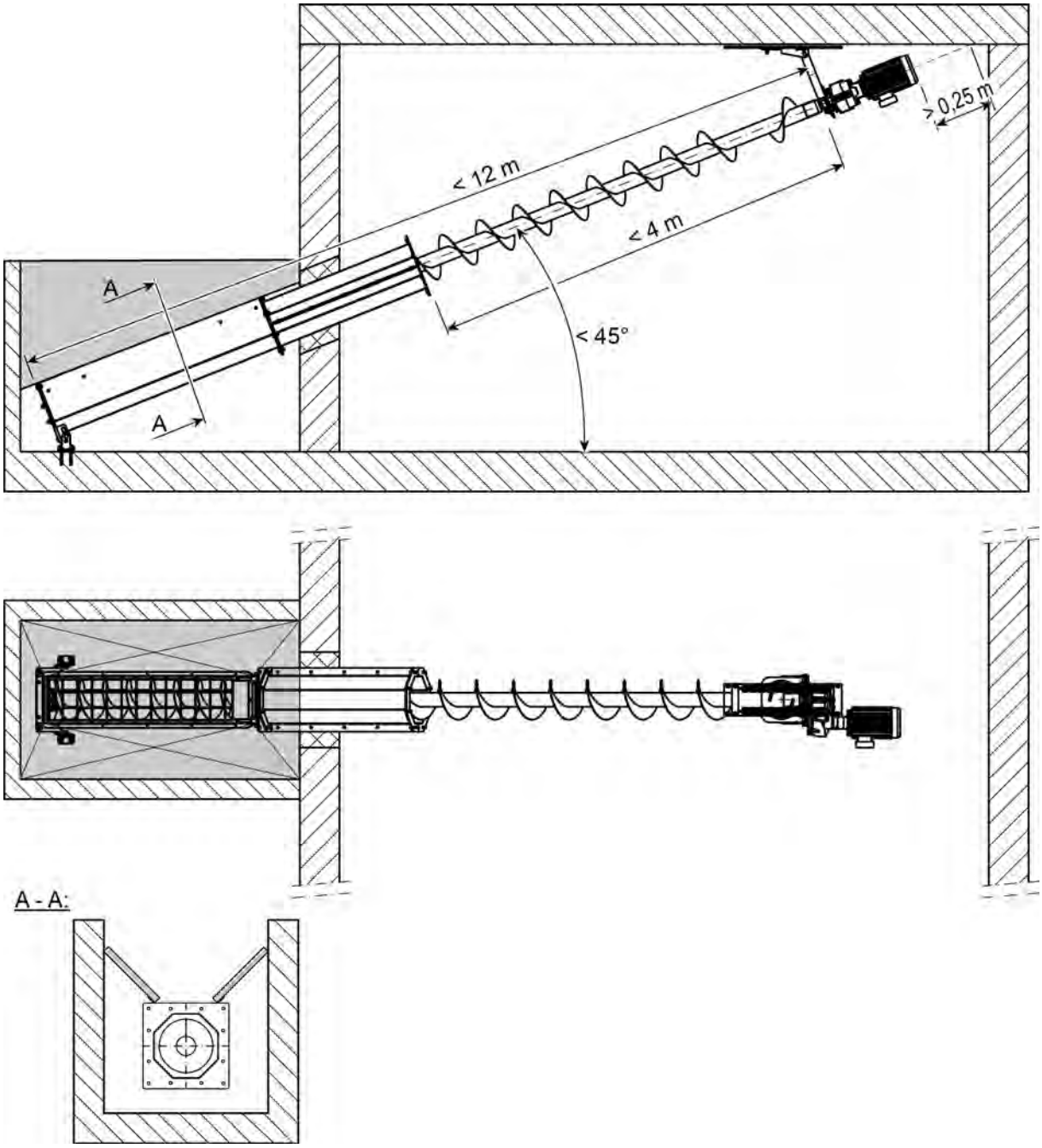
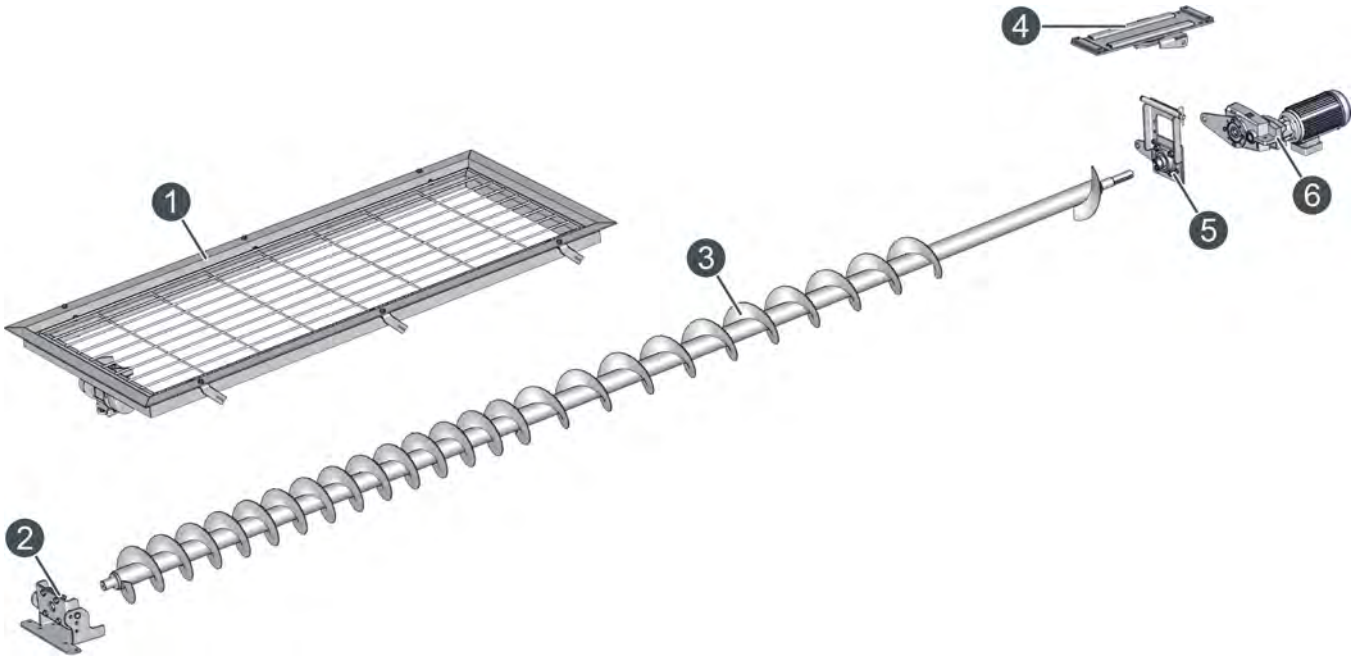


Fig. 5-2: Installation details

The filling hopper must be assembled on site. To improve filling, the filling hopper can be clad with wooden panels (see section A-A in the figure above).

5.1.2 Filling screw without trough

Design of the filling system



1 Safety grating (optional)
2 Bearing for conveyor screw
3 Conveyor screw (from 6 m in length, two-part)
4 Ceiling attachment
5 Bearing plate for conveyor screw
6 Drive motor with gearbox

Installation details

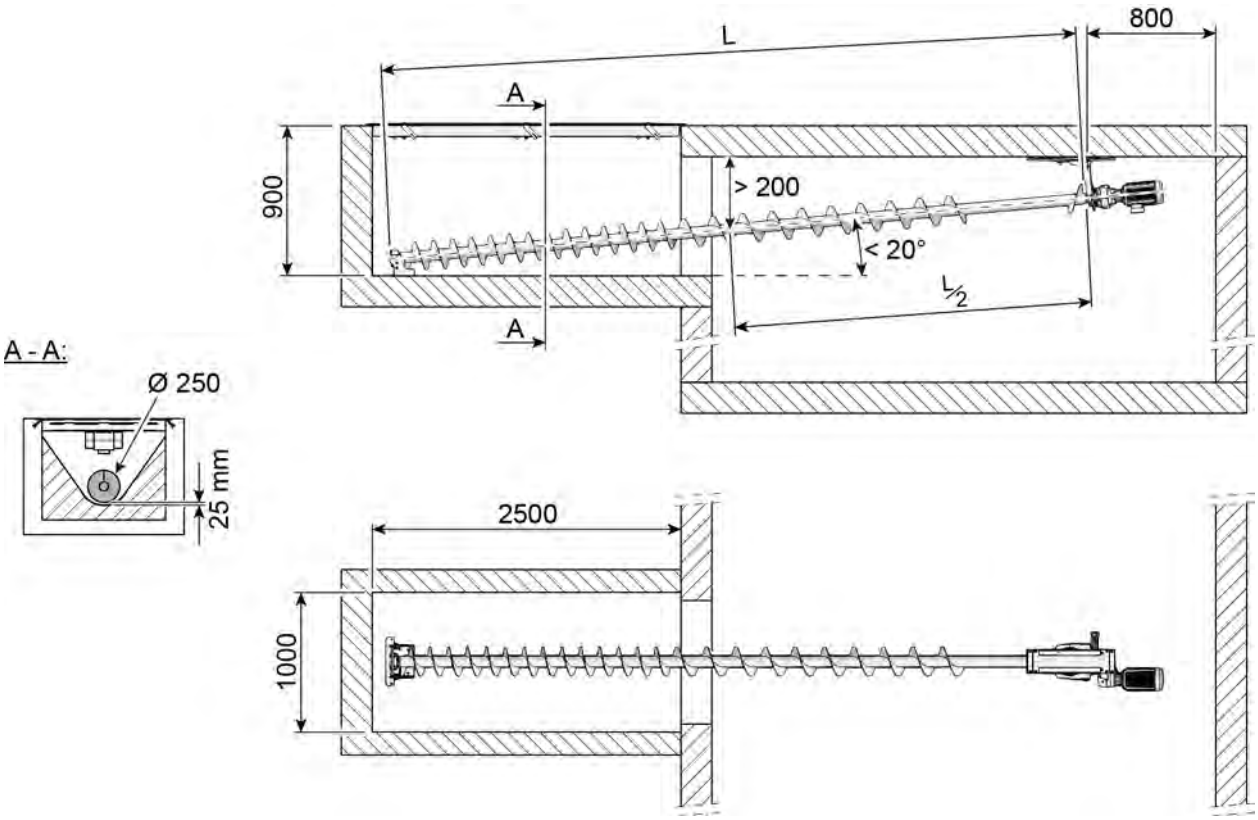


Fig. 5-3: Installation details

Note

- The safety grating is to be supplied by the customer.
- The conveyor screw must have a gap of 25 mm to the filling hopper. A DN 300 mm pipe can be used for panelling.
- The clearance from the midpoint of the conveyor screw to the ceiling must be at least 200 mm. Then the conveyor screw will not touch the ceiling when it is floating on the fuel.

5.2 Vertical screw

Vertical screw for filling

With the vertical screw and centrifuge, even high storerooms can be filled with wood chips (not pellets). The wood chips can be transported up to a height of 8 m. In order for the centrifuge to eject the wood chips widely and optimally in the storeroom, the ratio of fine material may not be too high.



Fig. 5-4: Vertical screw with centrifuge

The centrifuge is available in three versions. This allows installation in the storeroom in the centre (middle of the room) or on the left or right side (edge of the room). Filling systems with a centrifuge are planned according to customer specifications. The generally applicable details are as follows:

- All drives must be protected against the effects of weather on-site.
- Closed storerooms must be sealed to prevent dust from escaping.
- The maximum feed capacity depends on the material and is approx. 40 m³/h.
- The maximum throw distance is only achievable with G50 (50 mm) size wood chips (see the throw diagram).
- The shaft or the filling hopper must have an on-site water run-off.
- A fireproof and rainproof metal cover for the filling hopper is recommended.

The throw distance is represented in the following throw diagram relative to the drop height and the grain size (coloured areas).

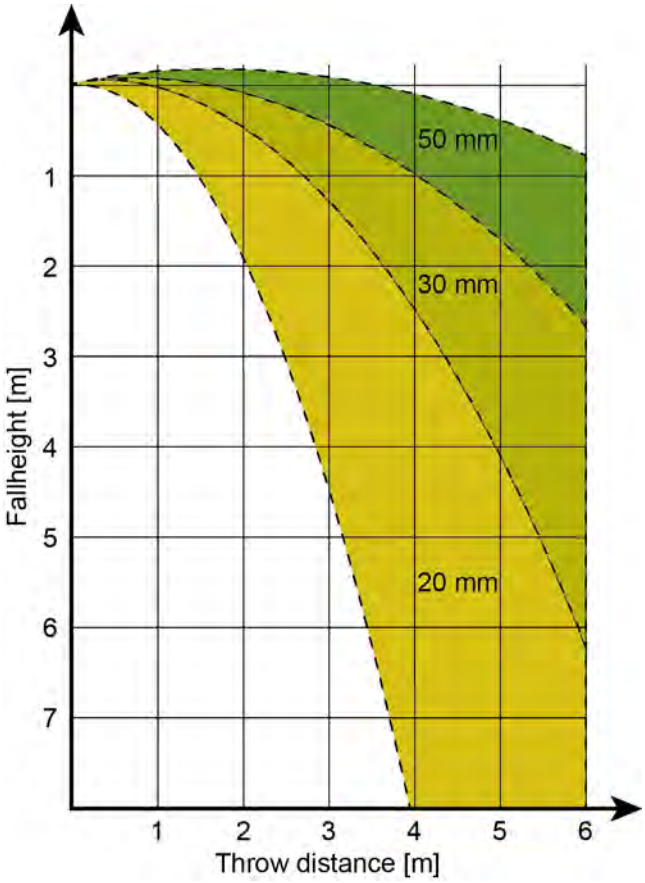


Fig. 5-5: Throw diagram

A filling auger can be installed instead of a centrifuge. Plans for this are available from ETA.



Fig. 5-6: Vertical screw with filling screw

5.3 Hack filling nozzle

Filling the storeroom by means of the filler neck

The filler neck can be installed in the masonry or in a window shaft to facilitate easy and quick filling. Only fine and dry wood chips can be poured in. Clarify with your wood chip supplier whether they have a tanker with a pump hose (DN 150) for filling.

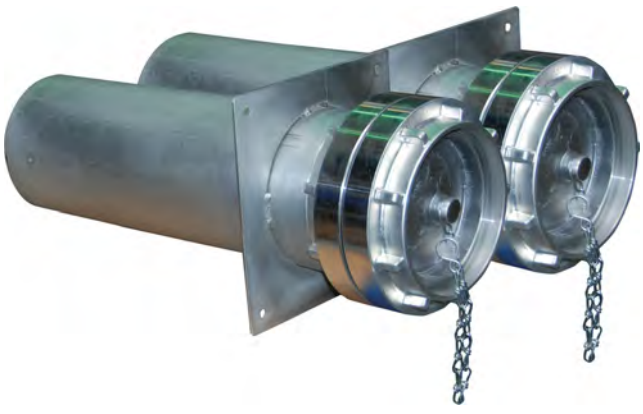


Fig. 5-7: Filling nozzle

6 External EEP precipitator

6.1 Functional description

Precipitator function

The following functional description is valid for the EEP50 external precipitator. It also applies analogously to other precipitators for boilers with higher capacities.

The draught fan sucks the boiler flue gas through the precipitator.

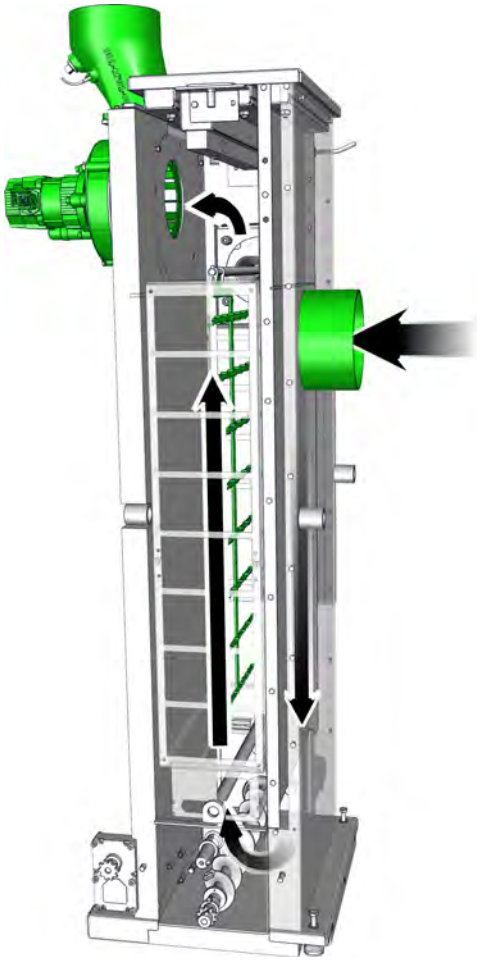


Fig. 6-1: Exhaust path

Inside the precipitator is the vertically oriented "discharge electrode," which is connected to the high voltage unit. The flue gas is cleaned as it flows through the electrical field. In the electrical field (up to 30 kV voltage), the discharge electrode "pushes" the dust particles from the flue gas to the inner wall of the precipitator. The dust particles accumulate there and the flue gas is cleaned as a result. Small quantities of dust will remain adhered to the electrode. Therefore, it is cleaned at regular intervals.

Deposits on the inner walls are removed by a sliding rake which moves up and down. The ash is transported on the bottom to the ash box by an ash screw.

WARNING!

Earthing of the boiler is required



Separate earthing is required for the boiler. To do so, a connection must be established between the boiler and the structural potential equalisation in the boiler room (minimum cross-section 6 mm²).

6.2 EEP250 precipitator

Precipitator de-ashing

De-ashing of the precipitator can optionally take place in an ash box or in an ash bin. When de-ashing with an ash bin, the bin can be mounted to the left, in the middle or to the right of the precipitator. The connections on the precipitator for the inlet and outlet of the flue gas (bypass) can be freely selected.

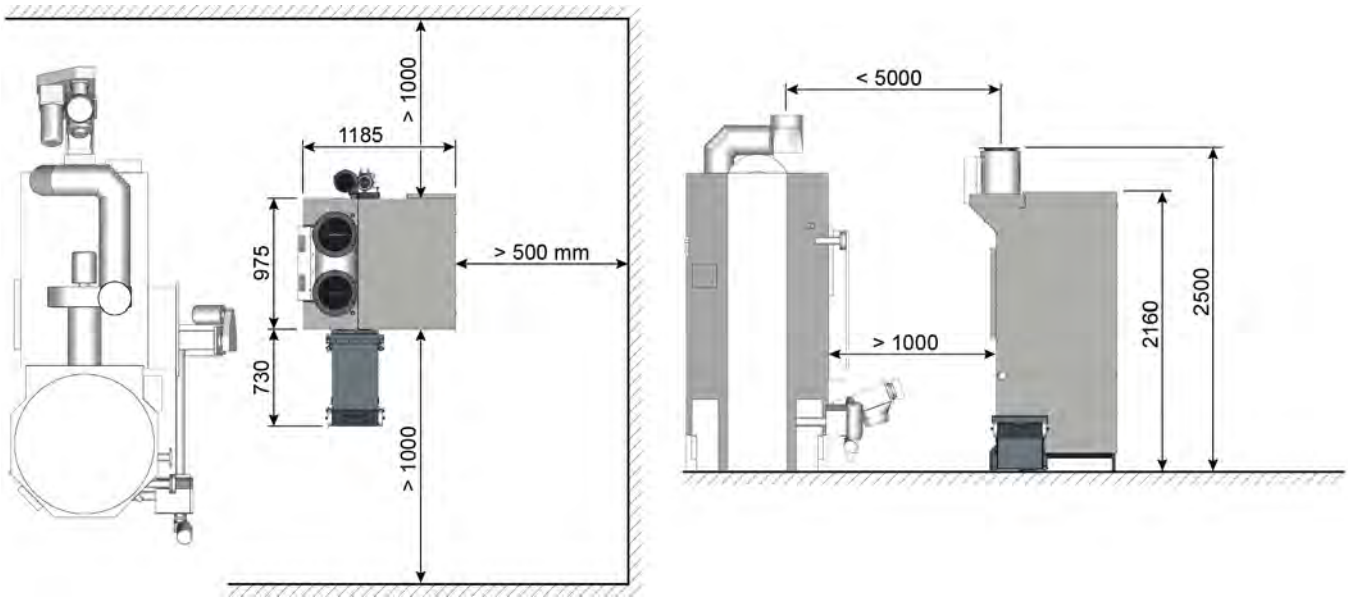


Fig. 6-2: De-ashing with the ash box

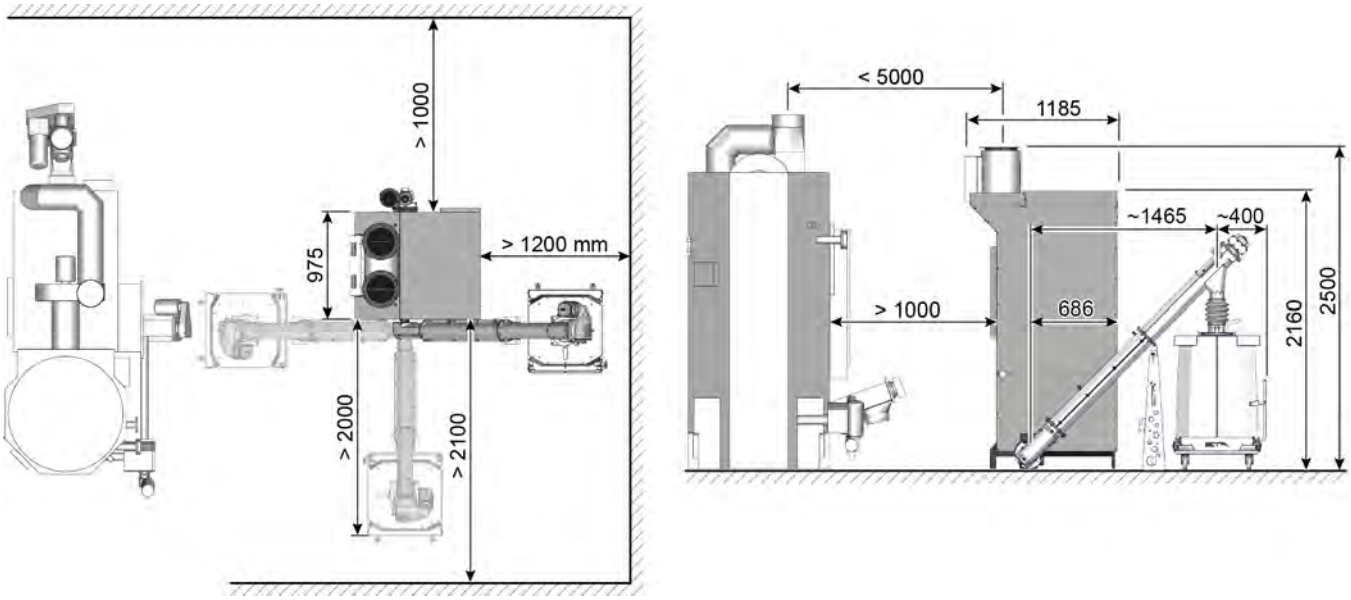


Fig. 6-3: De-ashing in an ash bin

Precipitator	Unit	EEP 250
Weight	kg	553
Electrical power consumption during operation (maximum value/regular operation)	W	518 / 187
Electrical power consumption in ready mode	W	4
Electrical connection	400 V AC / 50 Hz / 13 A / 3P+N+PE	

6.3 Precipitator EEP333-500

Precipitator de-ashing

De-ashing of the precipitator can optionally take place in an ash box or in an ash bin. When de-ashing with an ash bin, the bin can be mounted to the left, in the middle or to the right of the precipitator. The connections on the precipitator for the inlet and outlet of the flue gas (bypass) can be freely selected.

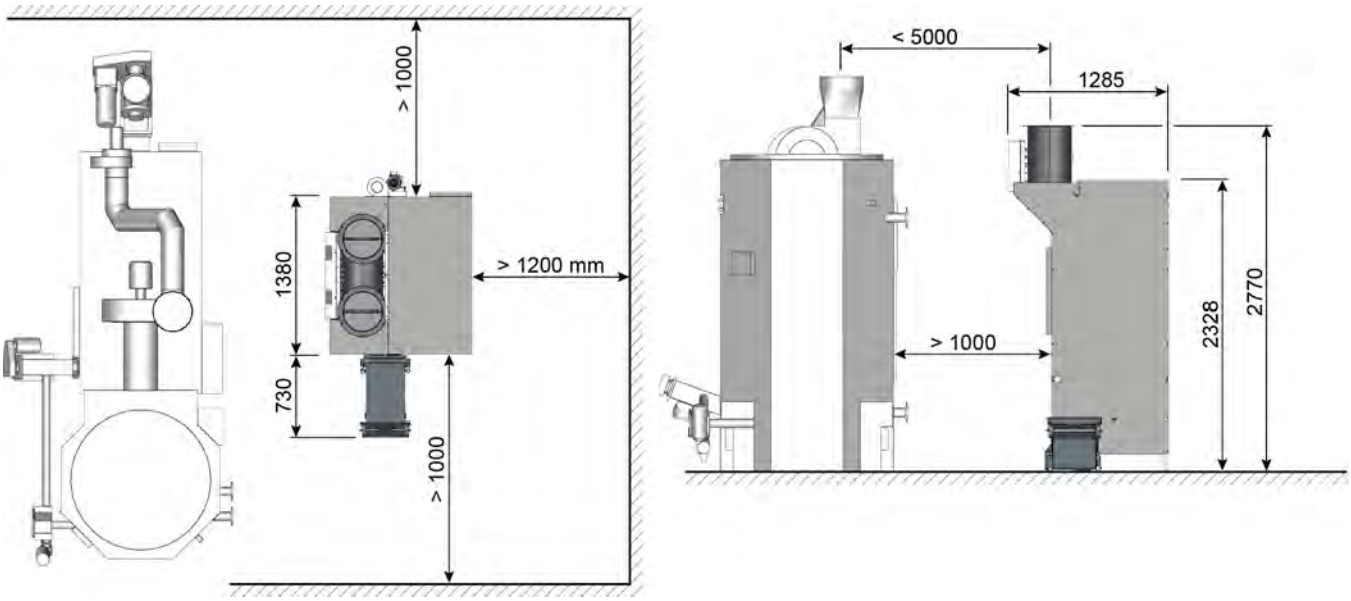


Fig. 6-4: De-ashing in an ash box

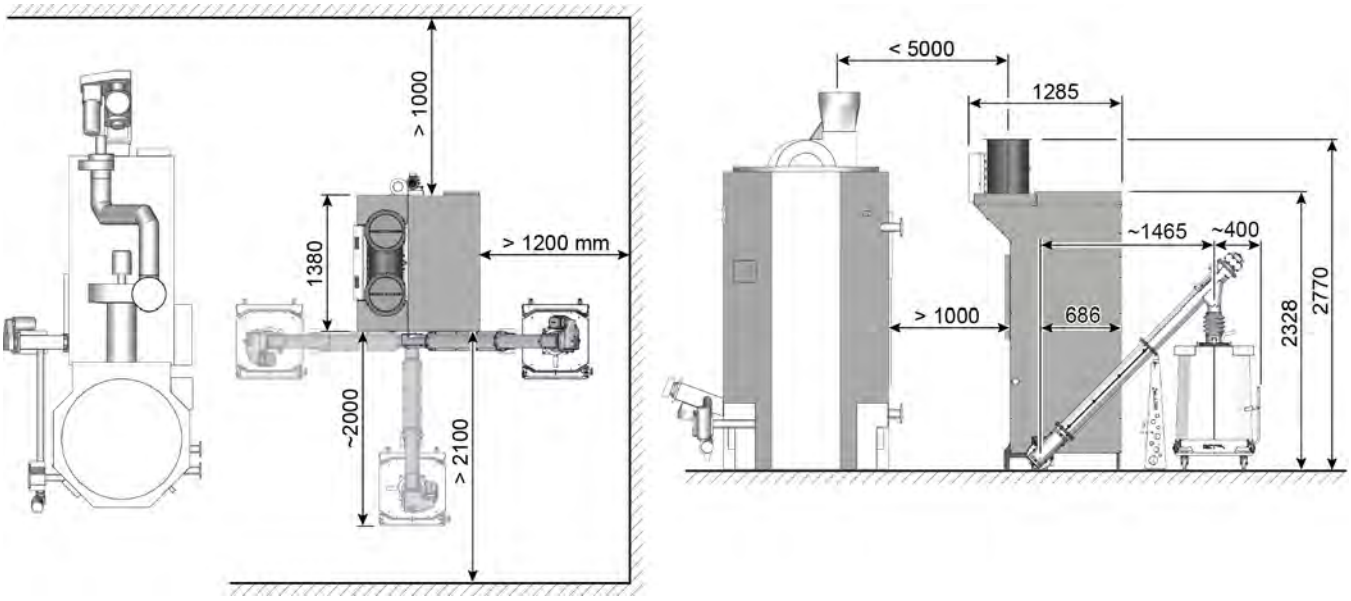


Fig. 6-5: De-ashing in an ash bin

Precipitator	Unit	EEP 333 / 500
Weight	kg	841
Electrical power consumption during operation (maximum value/regular operation)	W	578 / 247
Electrical power consumption in ready mode	W	4
Electrical connection	400 V AC / 50 Hz / 13 A / 3P+N+PE	

7 Information for planning

7.1 Regulations, standards and guidelines

Regulations for the implementation of the heating system

To implement and operate the system, the rules of technology and legal provisions are to be observed:

- Technical building laws and regulations, which can vary from state to state in Germany. Therefore, in case of doubt, contact the local construction authorities.
- Fire protection and the chimney are the responsibility of the district chimney sweep. He/she must be informed before starting installation and the suitability of the chimney must be clarified.
- As regards the safety of the heating system, EN 12828 "Heating systems in buildings" applies in the European Union. The specialist company carrying out the installation is especially liable for compliance.
- As regards electrical safety, national regulations and laws are to be complied with in addition to the EN standards. The electrical specialist company is especially liable for this.
- Wood and pellet heating is often sponsored by public authorities. Before ordering the system, please find out about the currently valid guidelines that must be met in order to be eligible.

Inspecting the boilers

The ETA boiler fulfils the requirements of EN 303-5 as regards the design, safety and emissions. This has been confirmed by testing carried out by BLT Wieselburg and TÜV Süddeutschland.

CE compliance

Compliance with EU guidelines and EN standards is the responsibility of the manufacturer and is confirmed with the CE mark on the type plate. In a CE declaration of conformity, which can be requested from the manufacturer (www.eta.co.at), the underlying guidelines and standards for series production are provided.

CE conformity is equivalent to national test marks, such as the "Ü mark" in Germany.

7.2 Noise emission

Airborne noise emission

In normal operation, the airborne noise emissions from a pellet or wood chip boiler is between 40 and 50 dB(a) with individual peaks of up to 75 dB(a) (ignition fan and pellets vacuum motor).

To limit airborne noise emissions, the usual measures that are required for all boiler rooms are sufficient:

- Heavy doors such as the legally prescribed fire doors
- Restriction of the air intake openings to the required minimum
- Sound absorption insulation in the floors of the rooms above

Structure-borne noise

Noise problems with pellet or wood chip boilers are primarily caused by structure-borne noise emissions, that is from the noise energy that is introduced into the building. The main structure-borne noise emission sources and required damping measures are listed in the following.

- **Squeaking and creaking of the fuel conveyor screws:**
  Squeaking and creaking from the fuel conveyor screw depends on the fuel used, which is why the volume can have a wide range. Even if these noise sources are negligible in 90% of systems, without measures to counteract structure-borne noise transmission, the limit value of 30 dBA (for domestic technical systems) can be exceeded in the adjacent living rooms for 10% of systems. For this reason, cover the screw in the wall opening with mineral wool to prevent noise being introduced into the wall. In the same way the store room should be set up on a floating screed to acoustically decouple the conveyor from the building.
- **Chimney noises through the draught fan:**
  For chimney noises through the draught fan, a soft integration (for example with a ceramic cord) of the flue pipe is used in the chimney connector for soundproofing.
- **Natural resonance of the chimney:**
  The natural resonance of a chimney occurs if the chimney emits a certain frequency from the boiler (pipe organ effect). As soundproofing for brick-built chimneys, additional insulation and sealing of the

cleaning openings helps. For metal chimneys, additional wall consoles attached to the masonry can help.

- **Noise emission through heat exchanger cleaning of the boiler:**
  For soundproofing, blocking de-ashing during night hours with the time programme available on the control system helps. So does a floating screed in the boiler room and setting up the boiler on the ETA sound-insulation set. Design the rigidly connected installation (flow and return, thermal emergency cooling valve) so that introduction of noise into the masonry is minimised.

7.3 Boiler room

Installation of the boiler

The boiler may only be installed in dry surroundings. The permitted ambient temperatures are between 5 and 30 °C.

The boiler may only be installed on a flat, non-combustible surface. The distance of flammable materials in the immediate vicinity of the boiler must be heeded in accordance with national regulations.

Requirements for the boiler room

Boiler rooms must be built with fire-resistant F90 (EI90) walls and ceilings; in Switzerland EI30 up to 70 kW and EI60 over 70 kW.

An escape door to a corridor or to the outside is required. The door F30 (EI30) must open in the direction of escape and be self-closing with a tight seal. Boiler room doors that open onto escape routes must be EI90 (F90).

The boiler room must feature air inlet and outlet vents with minimum diameters for the boiler.

To prevent flue gases from escaping, it must be ensured that negative-pressure does not occur in the boiler room. Building installations, such as suction for the ventilation system or installed compressors, for example, are thus not permissible.

Floor characteristics

The boiler may only be installed on a flat, non-combustible floor. The floor must be capable of supporting the boiler's weight. For more information see the chapter 12 "Technical data".

Sufficient lighting in boiler room

The boiler room must have lighting sufficient for the installation and commissioning of the boiler.

There must be no heating appliances in the vicinity of escape routes

Boilers may not be installed in stairwells, corridors or rooms through which escape routes lead to the outside.

Free minimum cross sections for the air intake openings

The boiler requires air for combustion. That is why free minimum cross sections are required in the boiler room for the air intake openings. In Austria, these are defined in ÖNORM H 5170, see the following table.

Boiler output [kW]	Free minimum cross sections in cm²		
	Austria (specification from ETA)	Germany	Switzerland
20	400	150	206
30	400	150	309
40	400	150	412
50	400	150	515
60	400	170	618
70	400	190	721
90	400	230	927
110	440	270	1133
130	520	310	1339
180	720	410	1854
200	800	450	2060
350	1400	750	3605
500	2000	1050	5150

Tab. 7-1: free minimum cross sections

A protection grille at the air intake opening also reduces the free cross section. Therefore, the air inlet opening must be larger depending on the protection grill. In air ducts through channels a calculation by a specialist is required.

The values listed may vary from country-specific and national regulations. Enquire about it at your authorities. If no rules exist, we recommend the Austrian minimum cross sections to use as a guide.

Too small-sized air inlet openings may result to low pressure in the boiler room. This can lead to a reduction of the boiler output, as well as to an exit of flue gas in the boiler room.

Boilers that are operated with an external air supply require no further supply air and outlet openings in the boiler room.

7.4 Bleeding

Protection against atmospheric corrosion

To reliably protect the entire heating system against corrosion, air intrusion should be kept to a minimum and any air that does gain entry must be released as soon as possible.

Bleeding at highest point in flow

No system is completely airtight. Air that gets into the system is transported to the boiler with the return flow since water can take up more air as it gets colder and as the pressure increases. The air is released again at the point in the system with the highest temperature and the lowest pressure. The two typical points for releasing gas are the hot boiler and the highest point in the heating system flow.

Install a bleed valve at the upper end of the pipe from the boiler outlet (already installed in PelletsUnit and PelletsCompact boilers) and also at the highest point in the flow of the entire system.

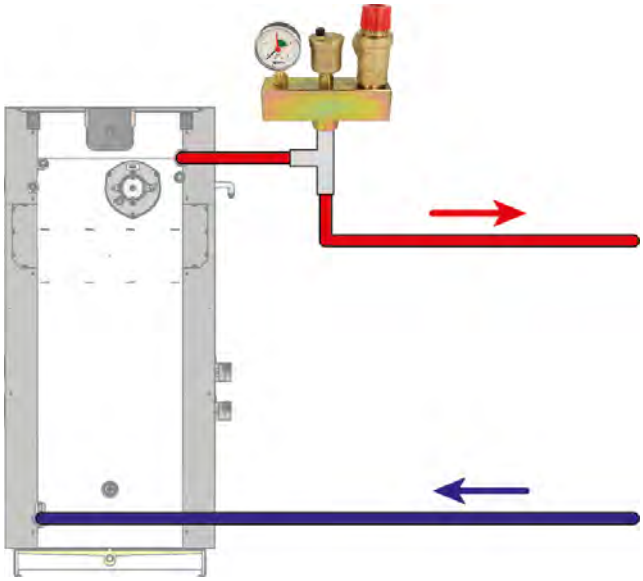


Fig. 7-1: correct positioning of the bleed valve

The T-piece of the bleed valve must be the same size as the boiler's flow connection, so that no air pocket may form. Likewise, the boiler body must be oriented horizontally, or ascending slightly toward the flow connection, so that air can escape.

For large, unseparated underfloor heating systems, an absorption filter for the entire water flow should be installed in the flow after the boiler (Spirovent, Flamco and Pneumatex are typical manufacturers).

Impermeable plastic tubing or system separation

Plastic tubing which is used must have DIN 4726 certification. As a rule, this is documented with a DIN test mark and a register number in the pipe label. Underfloor heating systems from older construction years often do not meet the requirements of the DIN standard from 1988. A considerable input of oxygen is to be expected here. The oxygen introduced can have a corrosion-promoting effect on various components in the heating system. A separation of the existing underfloor heating from the new boiler is required here. Although the limit values are not reached, the sum of the oxygen input via surface heating system, distribution, leakages, replenishment, etc. can also cause corrosion damage, especially in large systems (pipe lengths over 5000 running metres). A separation of the surface heating system from the heating boiler is recommended here. If damage to the boiler caused by the introduction of oxygen is proven, all claims under warranty and guarantee are void.

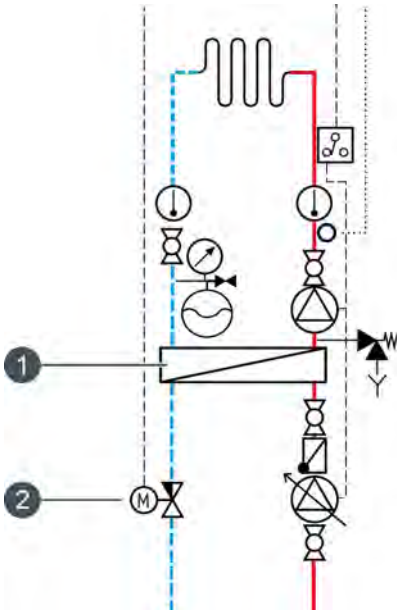


Fig. 7-2: System separation

1 Heat exchanger

2 Control valve

The hydraulically correct incorporation of the heat transfer station (regardless of whether for system separation or as a transfer station) must be adjusted on the primary side. In order to achieve optimal flow based on the flow temperature, the use of a two-way control valve (see graphic above) is recommended.

Additionally, the primary pump should be designed with differential pressure control. A system separation module with these specifications is available from ETA.



Fig. 7-3: ETA system separation module

No open expansion tanks

Open expansion tanks improperly allow air into the system. Existing systems with open expansion tanks must be redesigned or physically separated from the boiler.

Pressureless buffer storage may not be attached directly to the boiler. If it is not possible to replace this buffer, there must be a physical separation between the boiler and the pressureless buffer.

7.5 Water hardness

Determine the permissible water hardness for the heating water according to ÖNORM H 5195-1

Specific water content (litres/kW)		Table 1 Heat producer with large (> 0.3 l/kW) water content			Table 2 Heat producer with small (≤ 0.3 l/kW) water content		
		< 20 l/kW	≥ 20 /kW < 50 l/kW	≥ 50 l/kW	< 20 l/kW	≥ 20 l/kW < 50 l/kW	≥ 50 l/kW
Total output of the heat producer	≤ 50 kW	16.8 °dH	11.2 °dH	5.6 °dH	11.2 °dH	5.6 °dH	0.6 °dH
	> 50 kW ≤ 200 kW	11.2 °dH	5.6 °dH	2.8 °dH	5.6 °dH	2.8 °dH	0.6 °dH
	> 200 kW ≤ 600 kW	5.6 °dH	2.8 °dH	0.6 °dH	2.8 °dH	0.6 °dH	0.6 °dH
	> 600 kW	2.8 °dH	0.6 °dH	0.6 °dH	0.6 °dH	0.6 °dH	0.6 °dH

Instructions for determination:

1. Determine the water content of the heat producer (in litres) and divide it by its output (in kW). If the result is larger than 0.3 l/kW, Table 1 applies. If the value is smaller or equal to 0.3 l/kW, Table 2 applies.
2. Divide the total heating water volume (in litres) by the output (in kW) of the smallest heat producer. The result is the specific water content and this determines the column within the previously calculated table.
3. Read the data for the permissible water hardness from the respective line using the total output of the heat producer.

Example: a heating system with a 45 kW boiler and 1500 litre total water volume

1. The ratio of water content to output is more than 0.3 l/kW (117:45=2.6) => table 1.
2. The specific water content is 33,3 l/kW (1500÷45 = 33.3) => middle column in table 1.
3. The total output of the boiler is 45 kW; therefore, only the data from the first line (≤ 50 kW) are relevant.

The permissible water hardness in this example is 11.2 °dH.

Softening with a salt-regeneration ion exchanger

We recommend softening water with salt-regeneration ion exchangers, just as drinking water is softened. This method does not remove salt from the water. It replaces the calcium in the lime with sodium from the salt, and has considerable advantages. It is cheap and chemically stable against contamination. In addition, it produces a natural alkalinity that generally results in a sufficiently non-corroding pH value of around 8.

pH value between 8 and 9 may require dosing with trisodium phosphate

If the heating water's pH value has not itself changed to more than 8 after a week of operation, increase it by adding 10 g/m³ of trisodium phosphate (Na_3PO_4) or 25 g/m³ of trisodium phosphate dodecahydrate (Na_3-$PO_4.12H_2O$). Wait another 2-4 weeks before making further corrections. The pH value must not exceed 9.

No hybrid installations

A disadvantage of salt-regeneration ion exchange is the salt content with its high electrical conductivity, which can lead to electrolytic corrosion, especially of aluminium or galvanized steel. If only steel, brass, gunmetal and copper are used in the heating system and the use of stainless steel is limited to small areas, then no corrosion problems should be expected, even with salty water.

Galvanized and aluminium parts in a heating system are always in danger of corrosion, especially in combination with copper tubing. In practice, this means no hot-galvanized fittings and no mixing of galvanized tubing with copper tubing. There is an illogical exception: galvanized steel tubing combined with boilers or buffer storage tanks made of steel. Presumably, the uniform zinc layer dissolves uniformly and is dispersed evenly throughout the system without localised corrosion.

Complete desalination not required

If there is no aluminium (heat exchanger in the gas boiler or aluminium radiator) in the system, then costly complete desalination with ion exchange cartridges or osmosis is not required.

Lime stabilisation can be dangerous

The addition of lime stabilising agents prevents limescale. However, we advise against doing this. These agents increase the salt content and result in an undefined pH value. If the system is filled with large amounts of water, exactly the same agent must be used again. Mixing with other water additives or with antifreeze can result in corrosion.

8 Safety

8.1 General information

Operation only by trained personnel

The product may be operated by trained adults only. Training may be provided by the heating technician or our customer service. Please read the associated documentation carefully in order to avoid errors during operation and maintenance.

Persons who lack experience and knowledge as well as children may not operate, clean, or maintain the product.

Keep children away from the fuel store and storeroom

In fuel stores for wood chips, in particular, there is a danger that a hollow space may form above the agitator. Children playing on the pile of wood chips, or careless adults, could fall in and get buried or caught up in the discharge screw.

Keep fire extinguishers in a clearly visible location

In Austria, the minimum requirement is an ABC powder extinguisher with 6 kg. An AB foam extinguisher with 9 litres, which produces less damage when used, is preferable. The fire extinguisher should be kept outside the boiler room, visible and easily accessible. Even if country-specific regulations do not prescribe a fire extinguisher, we still recommend that you keep one in-house.



Fig. 8-1: Fire extinguisher

Storage of ash

The ash must be kept in non-flammable containers with covers for cooling. Never put hot ash into the waste bin!



8.2 Safety devices

Pump safety run, automatic heat dissipation at overtemperature

If the boiler temperature exceeds 90°C (factory setting) for any reason, the pump safety run will start. All heating pumps and boiler pumps that are connected to the boiler control system are switched on to dissipate heat from the boiler.

This action prevents the boiler temperature from rising further and triggering further safety devices such as the safety temperature limiter and the thermal relief valve.

The heat dissipation is limited by the maximum flow temperature set in the heating circuits and the target hot water temperature.

Install thermal emergency cooling valve against overheating

The safety heat exchanger built into the boiler must be connected by the heating technician to the house's cold water supply via a thermal relief valve to protect

the boiler against overheating if the pump fails. The minimum pressure in the cold water pipe must be 2 bar and the temperature must not exceed 15 °C.



Fig. 8-2: Thermal emergency cooling valve

Only thermal emergency cooling valves that correspond to the standard DIN EN 14597 (or comparable standards) may be installed. They must activate at 100 °C and have a flow rate of at least 2.0 m³/h. The clear width of the cold water supply and outlet may not fall below the nominal diameter of the safety heat exchanger.

The cold water supply must be connected to the upper connector of the safety heat exchanger; the lower connector serves as an outlet to the sewer. To prevent the supply line from being shut off accidentally, remove the levers from ball valves or the hand wheels from valves and hang them there with a piece of wire.

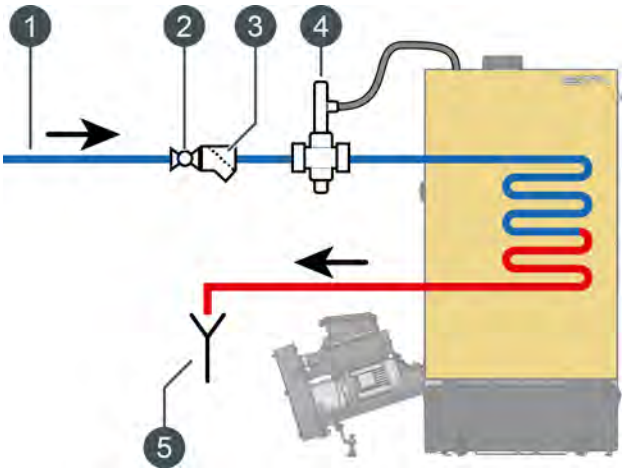


Fig. 8-3: Thermal emergency cooling valve

1 Cold water connection
2 Isolating valve; remove hand wheel
3 Strainer
4 Thermal emergency cooling valve
5 Visible outlet to sewer

The outlet must have an easily visible flow path so malfunctions can be recognised. Direct the discharged water to the sewer via a siphon funnel or at least with a pipe into the ground so that nobody can be scalded if the valve is activated.

Even for cold water coming from a domestic well with its own pump, a thermal emergency cooling valve must be installed on the boiler. With a generously dimensioned air vessel, enough water for cooling will come even if there is a power failure. If the power supply is very uncertain, a dedicated air vessel for the thermal emergency cooling valve is required.

Safety shutdown by safety temperature limiter

For additional safety against boiler overheating, a safety temperature limiter is built into the boiler. When a boiler temperature of 100 °C (tolerance +0°/-6 °C) is reached, the power supply to the draught fan and the fuel intake is interrupted. When the boiler temperature decreases back below 70°C, the safety temperature limiter can be manually released for a restart of the boiler.

Installing a safety valve against overpressure

A safety valve with 3 bar opening pressure must be installed on the boiler. Every heat producer in a heating system must be protected by at least one safety valve against pressure exceeding the maximum permissible operating pressure (see EN 12828). These valves must be designed such as to ensure the maximum permissible operating pressure that can arise in the heating system or parts thereof. The safety valve must be situated in the boiler room and be easily accessible.



Fig. 8-4: Safety valve

⚠ DANGER!

Do not install any shut-off valves, strainers or such like between the boiler and the safety valve.

The connection size of the safety valve is determined on the basis of the heating system's maximum heating capacity, as shown in the table.

Valve size[a] Nominal diameter (DN)	Maximum heating capacity (kW)
15 (G ½)	50

Valve size[a] Nominal diameter (DN)	Maximum heating capacity (kW)
20 (G ¾)	100
25 (G 1)	200
32 (G 1 ¼)	300
40 (G 1 ½)	600
50 (G 2)	900

a. The valve size is determined by the size of the inlet connection.

Install the safety valve at the highest point of the heat producer or in the flow pipe close to the heat producer. Only in this way can it discharge heat by blowing out hot water and steam.

The safety valve may be installed in any position, but the upper part of the valve must not face downward. The flow pipe may be 1 m long maximum and must be routed in a straight line in the nominal diameter of the valve inlet.

DANGER!

Safety valve outlet

The safety valve outlet must be directed to the ground in a pipe so nobody is endangered by hot water or steam.

▶ The safety valve outlet (vent pipe) must have at least the same nominal diameter as the valve outlet, be installed with a consistent gradient and be routed to a sewage system (e.g. duct). The vent pipe may contain a maximum of 2 bends and be 2 m long. If a length of more than 2 m is required, the next size of pipe must be selected. More than 3 bends and 4 m of length are not permitted. The mouth of the vent pipe must allow easy inspection and be routed such as to exclude any danger to persons. If the vent pipe ends above a funnel, its discharge pipe must have a cross section at least double that of the valve inlet.

8.3 Emergency stop switch

Emergency stop switch for the boiler

The EU Machinery Directive stipulates a lockable switch for the floor agitator in the fuel store. The best way of satisfying this requirement is to design the usual emergency stop switch as a key switch. This must be located immediately outside the access door, quite a bit higher than the light switch, and clearly labelled. For boiler rooms that are only accessible from outdoors, this emergency stop switch may also be inside the boiler room, immediately next to the access doors.

A single-pole, lockable switch or key switch is integrated in the boiler's safety chain. When actuated, this only stops the supply of fuel and combustion air. The pumps continue running to cool the boiler.

Emergency stop switch for the fuel store

We recommend fitting an additional emergency stop switch in the access area of the fuel store. Installation in the jamb of the access door has proven effective. The single-pole switch is integrated in the boiler's safety chain.

8.4 Safety devices in the fuel path

European standard EN 303-5

With EN 303-5 "Heating boilers for solid fuels... up to 500 kW" safety requirements have now been harmonised across Europe.

- **Spread of fire in the fuel supply pipe.**
  The one-chamber rotary valve installed as standard equipment (RSE according to TRVB 118 H) and the negative-pressure operation of the boiler prevent the propagation of fire (burn-back) in the fuel supply.
- **Heat conduction - surface temperature.**
  The surface temperature of the stoker may not exceed 85°C in any operating mode. This is ensured by the one-chamber rotary valve installed as standard. Without air, burn-back into the stoker is impossible.
- **Backflow of flammable combustion products into the store via the fuel supply pipe.**
  The single-chamber rotary valve installed as standard equipment and the negative-pressure operation of the boiler with a speed-controlled draught fan (DÜF according to TRVB 118 H) prevent a backflow into the fuel supply or the fuel store.
- **Shortage of combustion air or incomplete combustion.**
  A shortage of combustion air is prevented by standard residual oxygen measurement (FÜF according to TRVB 118 H), speed-controlled draught fan and position feedback for the air flaps. If there is a fault in the fan or the air flaps, a safety shutdown takes place.

Fire compartments in larger buildings

If a secure fire compartment is required between the boiler room and the fuel store in a larger building, then an automatic extinguishing system (sprinkler system) must be installed in the wall opening in addition to the requirements of EN 303-5.

Regulations for Austria - TRVB 118 H

During the official approval process, the authorised inspector can require compliance with TRVB 118 H "Technical directives for preventive fire safety" (Austrian Association of Fire Brigades and Austrian Fire Prevention Bodies).
A temperature monitoring system and manually activated fire extinguishing system, in particular, are also required:

- **Temperature monitoring system**
  This is installed in the wall opening of the conveyor screw from the fuel store to the boiler room; see Fig. 8-6: "Temperature monitoring system".

  In Austria, a capillary thermostat is supplied with all ETA wood chip boilers for this purpose.
- **Manually activated fire extinguishing system**
  This fire extinguishing system is installed above the wall opening of the conveyor screw from the fuel store to the boiler room for fuel stores measuring over 50 m³ and whenever fuel is stored in a barn (to be installed by the contractor, if required), see Fig. 8-7: "Manually activated fire extinguishing system".

Regulations for Germany

In Germany, previous requirements only stipulated one burn-back protection device in the fuel path and pressure monitoring of the combustion chamber. Now, with EN 303-5, a much more stringent safety standard is required, which ETA also fulfils.

Regulations for Switzerland - VKF 105-03d

In Switzerland, previously a burn-back protection device (flap, slider or rotary valve) and a sprinkler system on the stoker were required. Now, with EN 303-5, a much more stringent safety standard is required, which ETA also fulfils.

Single-chamber rotary valve as standard equipment

The standard configuration of ETA wood chip boilers with patented ETA one-chamber rotary valve and induced draught technique without fan, and with combustion chamber negative-pressure in all states of operation satisfies all requirements of EN 303-5 regarding fire propagation and recirculation of gases, as well as the requirements of TRVB 118 H. That provides reliable protection against back burning for wood chips and pellets.



Fig. 8-5: Single chamber rotary valve

Temperature monitoring system in the fuel store room

A thermostat must be installed in the wall opening for the conveyor screw from the wood chip store. It must trigger the connected warning device, such as a horn, if a temperature of approx. 70°C is exceeded. The sensor is inserted into the tube on the conveying system trough. The activation temperature of the thermostat is set to 65°C at the factory.



Fig. 8-6: Temperature monitoring system

1 Adjustable thermostat
2 Temperature sensor

Manually activated fire extinguishing system

This safety device floods the fuel store with water in the event of a fire. This system consists of non-flammable empty piping with a minimum nominal diameter of 20 mm and must be installed in the fuel store directly above the conveying system. The empty piping must

be connected to a pressurised water supply and equipped with a shut-off valve (a ball valve, for example), and labelled "Fire extinguisher for storeroom".

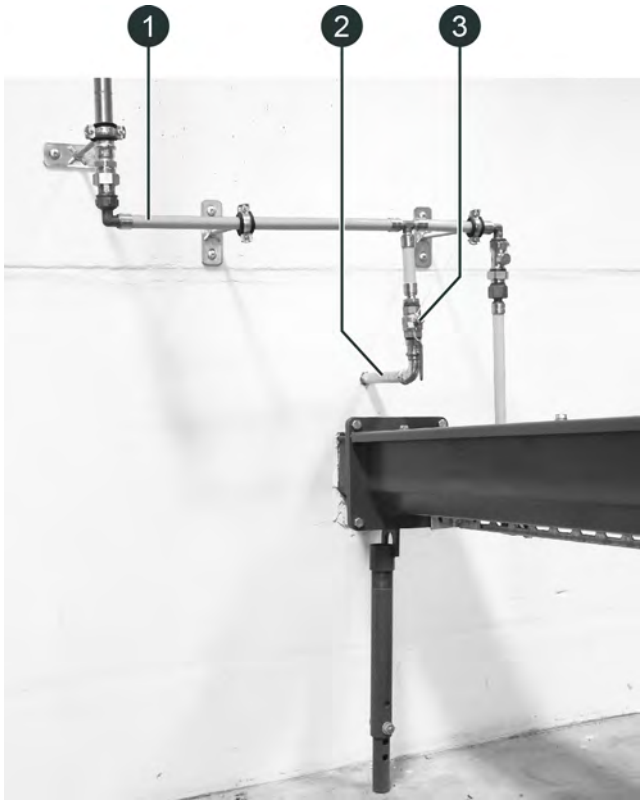


Fig. 8-7: Manually activated fire extinguishing system

1 Water supply
2 Empty piping (minimum nominal diameter 20 mm) in the fuel store
3 Ball valve

Securing the fire compartment in larger buildings or between a house and barn

An open fire in the boiler room can ignite the fuel in the discharge screw. This can cause the fire to spread to the store. If the boiler room and store are in the same fire compartment, special measures are unnecessary. If a fuel conveyor screw goes through the wall separating two fire compartments, then special measures are needed. The fire protection insulation recommended by the relevant standards for the conveyor screw in this situation is exposed to a high risk of damage due to the required maintenance openings, and so is not truly safe. An automatic sprinkler and a fire alarm (temperature-monitoring system) with lower activation threshold than the sprinkler, installed in the wall opening, provides a considerable increase in safety.

9 Chimney

9.1 Dimensioning

9.1.1 eHACK 20-50 kW

Required chimney diameter

Please note that in partial-load operation the exhaust temperature is lower and the large chimney diameters, normally used for solid fuel, are no longer ideal. If the cross section is too large, the flue gas no longer safely rises from the chimney opening and may flow along the roof and sink to the windows of the living quarters.

The flue gas connection on the boiler has two different diameters (see table). The flue pipe from boiler to chimney must be executed as per the requirements in the table. A flue pipe with a length of 2 m and with two 90° bends was assumed for the calculation. For some boilers a smaller chimney dimension (corresponding to the minimum diameter) can also be used. These values are listed in brackets. The "X" marks any diameters which may not be used.

Example: eHACK 50 with 10 m chimney height and DN130 flue pipe => a chimney with 15 cm diameter is required. Alternatively, a chimney with 14 cm diameter can be used.

No cross-sectional taper is permitted, such as a DN150 flue pipe in a chimney with a 13 cm diameter.

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm		
		eHACK, ePE-K 20, 25	eHACK, ePE-K 32	eHACK, ePE-K 45, 50
DN 130 DN 150	6 m	15 15	X 16 (15)	X 16 [a]
DN 130 DN 150	7 m	13 15	15 15	X 16 (15)
DN 130 DN 150	8 m	13 15	13 15	16 16 (15)
DN 130 DN 150	9 m	13 15	13 15	15 15
DN 130 DN 150	10 m	13 15	13 15	15 (14) 15
DN 130 DN 150	11 m	13 15	13 15	15 (14) 15
DN 130 DN 150	12 m	13 15	13 15	13 15
DN 130 DN 150	13 m	13 15	13 15	13 15
DN 130 DN 150	14 m	13 15	13 15	13 15

a. For boiler outputs over 30 kW and low chimney heights, a chimney joint tilted 45° can help achieve the required draught of 5 Pa at full load with acceptable cross-sections (a size smaller than indicated in the table).

9.1.2 eHACK 60-80 kW

Required chimney diameter

Please note that in partial-load operation the exhaust temperature is lower and the large chimney diameters, normally used for solid fuel, are no longer ideal. If the cross section is too large, the flue gas no longer safely rises from the chimney opening and may flow along the roof and sink to the windows of the living quarters.

The flue gas connection on the boiler has two different diameters (see table). The flue pipe from boiler to chimney must be executed as per the requirements in the table. A flue pipe with a length of 2 m and with two 90° bends was assumed for the calculation. For some boilers a smaller chimney dimension (corresponding to the minimum diameter) can also be used. These values are listed in brackets. The "X" marks any diameters which may not be used.

Example: eHACK 60 with 10 m chimney height and DN150 flue pipe => a chimney with 16 cm diameter is required. Alternatively, a chimney with 15 cm diameter can be used.

No cross-sectional taper is permitted, such as a DN180 flue pipe in a chimney with a 15 cm diameter.

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm		
		eHACK, ePE-K 60	eHACK, ePE-K 70	eHACK, ePE-K 80
DN 150 DN 180	6 m	X 18 [a]	X 20 [a]	X 20 [a]
DN 150 DN 180	7 m	X 18	X 18	X 18 [a]
DN 150 DN 180	8 m	16 [a] 18	X 18	X 18
DN 150 DN 180	9 m	16 18	18 18	X 18
DN 150 DN 180	10 m	16 (15) 18	18 18	X 18
DN 150 DN 180	11 m	15 18	18 (16) 18	18 18
DN 150 DN 180	12 m	15 18	16 18	18 18
DN 150 DN 180	13 m	15 18	16 18	18 18
DN 150 DN 180	14 m	15 18	16 (15) 18	18 (16) 18

a. For boiler outputs over 30 kW and low chimney heights, a chimney joint tilted 45° can help achieve the required draught of 5 Pa at full load with acceptable cross-sections (a size smaller than indicated in the table).

9.1.3 eHACK 100-130 kW

Required chimney diameter

Please note that in partial-load operation the exhaust temperature is lower and the large chimney diameters, normally used for solid fuel, are no longer ideal. If the cross section is too large, the flue gas no longer safely rises from the chimney opening and may flow along the roof and sink to the windows of the living quarters.

The flue gas connection on the boiler has two different diameters (see table). The flue pipe from boiler to chimney must be executed as per the requirements in the table. A flue pipe with a length of 2 m and with two 90° bends was assumed for the calculation. The "X" marks any diameters which may not be used.

Example: eHACK 110 with 8 m chimney height and DN200 flue pipe => a chimney with 20 cm diameter is required.

No cross-sectional taper is permitted, such as a DN200 flue pipe in a chimney with a 18 cm diameter.

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm			
		eHACK, ePE-K 100	eHACK, ePE-K 110	eHACK, ePE-K 120	eHACK, ePE-K 130
DN 180 DN 200	6 m	X 25 [a]	X 25 [a]	X 25 [a]	X 25 [a]
DN 180 DN 200	7 m	X 20 [a]	X 20 [a]	X 25 [a]	X 25 [a]
DN 180 DN 200	8 m	20 [a] 20 [a]	X 20 [a]	X 20 [a]	X 25 [a]
DN 180 DN 200	9 m	20 [a] 20 [a]	20 [a] 20 [a]	X 20 [a]	X 20 [a]
DN 180 DN 200	10 m	20 20	20 [a] 20 [a]	20 [a] 20 [a]	X 20 [a]
DN 180 DN 200	11 m	20 20	20 20	20 20	20 20
DN 180 DN 200	12 m	18 20	20 20	20 20	20 20
DN 180 DN 200	13 m	18 20	20 20	20 20	20 20
DN 180 DN 200	14 m	18 20	20 20	20 20	20 20

a. For boiler outputs over 30 kW and low chimney heights, a chimney joint tilted 45° can help achieve the required draught of 5 Pa at full load with acceptable cross-sections (a size smaller than indicated in the table).

9.1.4 eHACK 140-170 kW

Required chimney diameter

Please note that in partial-load operation the exhaust temperature is lower and the large chimney diameters, normally used for solid fuel, are no longer ideal. If the cross section is too large, the flue gas no longer safely rises from the chimney opening and may flow along the roof and sink to the windows of the living quarters.

The flue gas connection on the boiler has two different diameters (see table). The flue pipe from boiler to chimney must be executed as per the requirements in the table. A flue pipe with a length of 2 m and with two 90° bends was assumed for the calculation. The "X" marks any diameters which may not be used.

Example: eHACK 150 with 8 m chimney height and DN250 flue pipe => a chimney with 25 cm diameter is required.

No cross-sectional taper is permitted, such as a DN250 flue pipe in a chimney with a 20 cm diameter.

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm			
		eHACK, ePE-K 140	eHACK, ePE-K 150	eHACK, ePE-K 160	eHACK, ePE-K 170
DN 200 DN 250	6 m	X 25 [a]	X 25 [a]	X 25 [a]	X 30 [a]
DN 200 DN 250	7 m	X 25 [a]	X 25 [a]	X 25 [a]	X 25 [a]
DN 200 DN 250	8 m	25 [a] 25	X 25	X 25	X 25
DN 200 DN 250	9 m	25 25	25 [a] 25	25 [a] 25	25 [a] 25
DN 200 DN 250	10 m	25 25	25 25	25 [a] 25	25 [a] 25
DN 200 DN 250	11 m	25 25	25 25	25 25	25 25
DN 200 DN 250	12 m	20 25	25 25	25 25	25 25
DN 200 DN 250	13 m	20 25	20 25	25 25	25 25
DN 200 DN 250	14 m	20 25	20 25	25 25	25 25

a. For boiler outputs over 30 kW and low chimney heights, a chimney joint tilted 45° can help achieve the required draught of 5 Pa at full load with acceptable cross-sections (a size smaller than indicated in the table).

9.1.5 eHACK 180 - 240 kW

Required chimney diameter

Please note that in partial-load operation the exhaust temperature is lower and the large chimney diameters, normally used for solid fuel, are no longer ideal. If the cross section is too large, the flue gas no longer safely rises from the chimney opening and may flow along the roof and sink to the windows of the living quarters.

The flue gas connection on the boiler has two different diameters (see table). The flue gas connection with DN200 must not be used with this boiler. The flue pipe from boiler to chimney must be executed as per the requirements in the table. A flue pipe with a length of 2 m and with two 90° bends was assumed for the calculation. The "X" marks any diameters which may not be used.

Example: eHACK 200 with 8 m chimney height and DN250 flue pipe => a chimney with 30 cm diameter is required.

No cross-sectional taper is permitted, such as a DN250 flue pipe in a chimney with a 20 cm diameter.

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm			
		eHACK, ePE-K 180	eHACK, ePE-K 200	eHACK, ePE-K 220	eHACK, ePE-K 240
DN 200 DN 250	6 m	X 30 [a]	X 30 [a]	X 30 [a]	X 35 [a]
DN 200 DN 250	7 m	X 30	X 30 [a]	X 30 [a]	X 30 [a]
DN 200 DN 250	8 m	X 30	X 30	X 30	X 30 [a]
DN 200 DN 250	9 m	X 30	X 30	X 30	X 30
DN 200 DN 250	10 m	X 25	X 30	X 30	X 30
DN 200 DN 250	11 m	X 25	X 25	X 30	X 30
DN 200 DN 250	12 m	X 25	X 25	X 25	X 30
DN 200 DN 250	13 m	X 25	X 25	X 25	X 30
DN 200 DN 250	14 m	X 25	X 25	X 25	X 25

a. For boiler outputs over 30 kW and low chimney heights, a chimney joint tilted 45° can help achieve the required draught of 5 Pa at full load with acceptable cross-sections (a size smaller than indicated in the table).

9.1.6 for moving grate boiler

Required chimney diameter

Please note that in partial-load operation the exhaust temperature is lower and the large chimney diameters, normally used for solid fuel, are no longer ideal. If the cross section is too large, the flue gas no longer safely rises from the chimney opening and may flow along the roof and sink to the windows of the living quarters.

The flue pipe from boiler to chimney must be executed as per the requirements in the table. A flue pipe with 3 m length and two 90° bends was assumed for the calculation. For some boilers a smaller chimney dimension (corresponding to the minimum diameter) can also be used. These values are listed in brackets.

Example: HACK VR 250 with 10 m chimney height and DN250 flue pipe => a chimney with 30 cm diameter is required. Alternatively, a chimney with 28 cm diameter can be used.

No cross-sectional taper is permitted, such as a DN300 flue pipe in a chimney with a 28 cm diameter.

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm HACK VR 250
DN 250	7 m	35[a]
DN 250	8 m	35[a]
DN 250	9 m	35 (30)
DN 250	10 m	30 (28)
DN 250	11 m	30 (28)
DN 250	12 m	30 (28)
DN 250	13 m	30 (28)
DN 250	14 m	30 (28)

a. For boiler outputs over 30 kW and chimney heights under 8 m, a chimney joint tilted 45° can help achieve the required draught of 5 Pa at full load with acceptable cross-sections (one size smaller than indicated in the table).

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm HACK VR 333 HACK VR 350
DN 300	7 m	40[a]
DN 300	8 m	40[a]
DN 300	9 m	40
DN 300	10 m	35
DN 300	11 m	35
DN 300	12 m	35
DN 300	13 m	30
DN 300	14 m	30

a. For boiler outputs over 30 kW and chimney heights under 8 m, a chimney joint tilted 45° can help achieve the required draught of 5 Pa at full load with acceptable cross-sections (one size smaller than indicated in the table).

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm HACK VR 463 HACK VR 500
DN 350	7 m	60[a]
DN 350	8 m	50[a]
DN 350	9 m	45
DN 350	10 m	45

Diameter of the flue pipe from boiler to chimney	Chimney height above the boiler room floor	Required chimney diameter in cm HACK VR 463 HACK VR 500
DN 350	11 m	40
DN 350	12 m	40
DN 350	13 m	40
DN 350	14 m	35

a. For boiler outputs over 30 kW and chimney heights under 8 m, a chimney joint tilted 45° can help achieve the required draught of 5 Pa at full load with acceptable cross-sections (one size smaller than indicated in the table).

9.2 Planning and layout

Clarify with the chimney sweep

A specialist or a chimney sweep must inspect the dimensions and suitability of existing chimneys especially before boiler installation.

DANGER!

Every boiler must have its own chimney

Although it is not expressly prohibited, each boiler needs its own chimney or chimney pipe.
Only then can it be ensured that, under every boiler operating condition, the flue gas is safely conveyed outside and cannot enter the living space, for example, via the flue pipe of another boiler.

▶ Connect the boiler to a suitable and separate chimney.

DANGER!

Do not connect fan-assisted boilers and gas boilers to the same chimney

Most gas-fired boilers do not have a sealed air flap, and if the fan-assisted boiler is started when the chimney is cold, the flue gas is pushed through the gas boiler into the boiler room. This is not greatly helped by a flue gas damper in the flue pipe of the gas boiler, as these dampers are not certain to seal well on closing.

In the case of atmospheric gas boilers, old fireclay chimneys only stay dry due to the gas boiler's overflow opening. The water from the flue gas condenses in the chimney. During heating pauses, air flows through the overflow opening and dries the chimney. If this air flow is blocked by a flue gas damper, the moisture can destroy an old fireclay chimney.

DANGER!

Do not connect fan-assisted boilers and wood-burning stoves to the same chimney

Although not expressly prohibited, connecting a fan-assisted boiler and a wood-burning stove to the same chimney is a dangerous combination. For every wood-burning stove has an air intake. When the chimney is cold, any fan-assisted boiler, whether it burns oil or wood, will blow flue gas through this opening into the living area. If the wood-burning stove's firebox door is not closed and the boiler is defective at the same time, acute carbon monoxide poisoning is even possible.

Wood-burning stoves require a considerably larger chimney diameter, which cannot be heated by the fan-assisted boiler. Cold flue gas does not rise from the opening; it sinks and can reach living quarters through open windows. Moreover, it may be possible to hear the boiler's fan in the living quarters through the wood-burning stove.

Obsolete regulations stipulate the wrong chimney

Laws and regulations demand a moisture-resistant flue system for oil and gas and one that is resistant to soot fires for solid fuels.

Wood is a solid fuel. However, in the lower output range, the temperature of the flue gas can be below 100?, and condensates can be deposited in the chimney. The chimney must therefore be moisture-resistant, "contrary to regulations". Builders making a chimney resistant to soot fires in compliance with the law must then look on helplessly as the condensate destroys the chimney wall.

Soot fires are possible in natural-draught boilers or wood-burning stoves regulated by throttling the air supply. When the wood fire is at full intensity and the boiler temperature has been reached, a thermostat closes the air flap. This stops combustion. However, as the combustion chamber temperature doesn't fall, the wood continues to gasify. Unburned wood gas condenses to tar in the chimney, which can be ignited by sparks from the fire.

With modern, lambda-controlled wood boilers, soot fires of this kind are virtually impossible, as the control system restricts wood gasification, not the air. In modern,lambda-controlled wood boilers, the control system shuts down the fire by stopping the fuel supply, without closing off the supply of air to the fire. This way, there is no lack of air and no flammable tar in the chimney. In addition, the low flue gas temperatures of modern wood boilers also provide no ignition source for a soot fire. Modern and properly maintained wood boilers therefore pose no danger to chimneys from soot fires.

Moisture-resistant W3G flue systems

Since 2005, W3G chimneys (classified according to the German DIN 18160) exist that are resistant to both moisture and soot fires. These chimneys are approved for all fuels. Most of these W3G chimneys have ceramic inner pipes, which have a significantly longer service life than metal chimneys due to their acid resistance.

A draught limiter is required for boilers with flue gas recirculation

If the boiler is equipped with flue gas recirculation, such as the PE-K pellet boiler (or eHack wood chip boilers with optional flue gas recirculation), a draught limiter must always be installed in the chimney.



Fig. 9-1: Draught limiter

Flue gas recirculation conveys a portion of the flue gas back to the boiler to cool the combustion chamber. An overly strong flue draught prevents the recirculation to the boiler and the flue gas reaches the chimney immediately, thus rendering the flue gas recirculation ineffective. This leads to slag formation and increased wear on the boiler.



Fig. 9-2: optimum placement of the draught limiter

At a minimum, the draught limiter must correspond to the diameter of the chimney and should optimally be connected 0.5 m below the flue tube connector in the chimney. If that is not possible, installation in the connection pipe to the chimney is required. Example:
Chimney: dia. 220 mm
Connection pipe to chimney: dia. 180 mm
=> a draught limiter of at least 220 mm diameter is required.

Provide a short, ascending flue pipe to the chimney

The flue pipe from the boiler to the chimney must be short, leakproof and ascending. "Attractive" right-angle flue offsets with two or more bends are bad in a flue pipe. The optimum to strive for is the shortest pipe from the boiler to the chimney with a minimum of directional changes. The flue pipe to the chimney must be leakproof. Use heat-resistant silicone as a sealant for unsealed sleeve pipes. Otherwise, you can expect smoke to escape into the boiler room as the boiler heats up. The flue pipe must always be laid so that it ascends towards the chimney.

Long horizontal flue pipes to the chimney must have a narrow cross-section and above-average insulation (> 50 mm). Provide enough cleaning openings in the flue pipe. A flue pipe to the chimney with a large cross section would reduce the calculated required chimney cross section. However, ash deposits will form at low flow speeds, and the theoretically calculated flue draught will be lost again.

With a large chimney cross-section, a maximum straight length of the flue pipe up to half the effective chimney height is possible (calculation required).

Connection to the sewage system for the chimney

For the condensate in the chimney, a connection to the sewage system (e.g. duct) with at least DN25 via a siphon is required. The sewer pipe to which the condensation drain pipe is connected should be flushed once a year.



Fig. 9-3: Condensate drain

For chimneys on the outer walls (made of stainless steel, for example), frost-proof run-off must be provided for the condensate water.

Insulate flue pipe to chimney

The flue pipe from the boiler to the chimney should be insulated with at least 30 mm, preferably 50 mm, of mineral wool to avoid temperature losses, which can lead to a build-up of condensation.

Prevention of structure-borne noise

There should not be a fixed connection between the flue pipe and the chimney to prevent structure-borne noise as much as possible! Good flue gas systems are acoustically insulated. If steel pipes are connected to a fireclay chimney, ceramic fibre bandages have proven effective at preventing structure-borne noise as well as damage to the fireclay sleeve.

Cleaning opening in flue pipe

Easily accessible cleaning openings must be available for cleaning the flue pipe.



Fig. 9-4: Cleaning opening

Fit the chimney connection just under the ceiling

Even if the current boiler can be connected to the chimney at a low height, it is better if you fit the chimney connection just below the ceiling. The flue pipe is easier to install, and the vertical connecting pipe is long enough for an emission measurement.

A second chimney connection below the first one enables simple installation of a draught limiter, if this is required.

Deflagration damper

The boiler is designed with safety routines in the control system to prevent deflagrations. Thus, no deflagration damper (also often called an explosion flap) is required for a boiler output up to 50 kW if the flue pipe is short and ascends to the chimney.



Fig. 9-5: Example: deflagration damper with draught limiter

We recommend using a deflagration damper for boiler outputs of 60 kW and up. A deflagration damper is required for boiler outputs of 100 kW and up. While the most that can happen in smaller boilers in the event of a deflagration is that the flue pipe to the chimney can be pulled apart, in larger boilers the gas volume is already so large that a boiler door can be blown off.

For high points before descending sections or at the beginning of a long horizontal section (L > 20 x D), a deflagration damper is required regardless of the boiler output.

DANGER!

Position of the deflagration damper

▶ Position the deflagration damper so that no people are endangered.

9.3 Renovation

Chimney renovation before it's too late

Compared to older boilers, modern ones are more efficient and have lower amounts of flue gas and considerably lower temperatures.

Chimneys with a "too large diameter", in particular, can no longer be heated adequately. The moisture contained in the flue gas condenses in the chimney, resulting in the very slow but inexorable destruction of old masonry chimneys.

Furthermore, the exit velocity and temperature are too low if the diameter of the chimney is too large. The flue gas then lacks the energy to rise and, in extreme cases, the smoke can sink down along the roof.

If your chimney does not have a moisture-resistant liner or its diameter is too large, it will require renovation in the form of a new, moisture-resistant liner. Narrow chimneys can also be renovated by the addition of stainless steel pipes.

Also keep in mind that chimneys have a limited service life. Timely renovation before destruction of the chimney wall can be achieved quickly and easily by inserting a tube. But if the flue gas condensates have penetrated the mortar joints, the entire chimney must be dismantled and rebuilt.

Chimney renovation with a stainless steel pipe

Maybe the chimney has already been renovated for oil or gas with a stainless steel pipe, and now a conversion to wood or pellets is planned. Or the chimney is too narrow to install a ceramic pipe with a reliable seal. If a moisture-resistant inner pipe is installed in a sufficiently fire-resistant casing, the German Association of Chimney Sweeps has found the following solution to the standards and regulations dilemma: "in the certification of suitability and safe use for heating systems, it should be noted that after a soot fire the long-term durability cannot be ensured and penetration of the chimney by moisture cannot be ruled out so that it may be necessary to replace the inner pipe (Criteria for Determination of Suitability and Safe Use of Heating Systems - October 29th 2008, page 12).

Replacing the inner pipe and seals after a soot fire

The boiler is equipped with safety routines to prevent soot burning. Nevertheless, in very rare cases, it is possible that a soot fire may occur in the chimney. After that, it is very likely that the inner pipe of the chimney and the flue pipe from the boiler to the chimney will no longer be tight.


For safety's sake, have the chimney checked by a specialist or chimney sweep. The inner pipe should also be replaced and the seals in the flue pipe from the boiler to the chimney should be replaced.

10 Buffer storage tank

10.1 General information

Why a buffer storage tank?

Many old log boilers that do not have buffer storage tanks are still in use, so why do we need them with today's wood-burning systems? The answer to this frequently asked question: Earlier, in the days before heating control systems, the boiler used the thermal mass of the entire house as a buffer.

Now if the boiler is replaced and the radiators are fitted with new thermostat valves and/or a weather-dependent mixing system, the log boiler is forced to operate at too low an output level in autumn and spring when the heating requirements are minimal.

At low output levels, the temperature in the combustion chamber drops, but production of wood gas doesn't. Hard-to-burn components of the wood gas such as tar or acetic acid no longer combust; instead, they condense (create tar deposits) either in the boiler's heat exchanger or in the chimney. The materials that are not deposited pollute the environment. To master this low-load operation, which inevitably occurs in a modern, energy-saving heating system, the boiler has to operate with small outputs. But the lowest output of the boiler can still be higher than the heat consumer can take. That is why a buffer storage tank is recommended to store excess heat in it and to supply it back into the heating system when required.

When is a buffer storage tank necessary?

A buffer has to be installed for the boiler under the following conditions:

- if individual room temperature control is installed.
- for more than two heating circuits.
- especially in apartment buildings where the flats are individually controlled.
- in low-energy houses, when a substantial portion of the boiler's operating time is spent below its output range.
- during the transitional period in autumn/spring when there is very low heating demand, such as only for the bathroom.
- for wooden houses with low heat capacity and radiator heating.
- if above-average hot water demand or high spikes in hot water use are expected, e.g. in hotels, blocks of flats, showers in sports facilities. A pellet boiler needs up to 20 minutes (wood chip boiler up to 45 minutes) to reach its maximum output from standby.
- if an air heating system is to be started without warm-up time for the boiler.
- if a solar heating system is being integrated with a low-temperature heating system (underfloor heating).

Individual room temperature control is only possible with one buffer

A buffer storage tank reduces the number of on/off cycles to an energy-saving and gentle minimum.

Through the separation of production and consumption, the room control does not have to take the boiler into consideration. Only the currently required heat is removed from the buffer.

This makes needs-based heating of individual rooms possible, for example in the morning only bathroom and kitchen, or only the rooms in the north of the house if the rooms in the south are directly heated by the sun.

At low heating loads, either install a buffer or set short heating time slots

For very well-insulated brick walls (not for wooden construction), the house itself is an excellent thermal store. If the boiler output is too high, it can be adjusted to the house's heating requirements by limiting the heating time to three short time slots spread over the day.

If there is very low heat consumption during the transitional period in autumn/spring (e.g. heating only in the bathroom), then a buffer storage tank is needed for this low heating load.

Wooden houses need a buffer storage tank

For a wooden house with radiator heating, where there is not even the screed of an underfloor heating system to act as a thermal store, the installation of a buffer should be considered.

With a design output less than 70% of the boiler's rated output, an underfloor heating system operating only with time slots will cause large temperature variations in the rooms and a buffer storage tank is required. Heat produced by the boiler and not currently needed in the house can be stored in a buffer storage tank and returned to the heating system when needed.

For large hot water demand

A large demand for hot water often occurs for showers in sports clubs, large apartment blocks or hotels.

A pellets or wood chip boiler requires 20 minutes from standby to full output. To bridge this start time for large and instant hot water demand, either large hot water tanks or larger buffers are required.

To really maintain the hot water peak load, the upper temperature sensor (to start buffer charging) both in the hot water tank as well as the buffer are to be set very low. It may be necessary to reweld a sensor sleeve.

Air heaters and heating fans

For air heaters that are not operated continuously (air heat exchangers), and which are started without a boiler warm-up time, a buffer storage tank is required to prevent the heater from blowing cold air at start up. In practice, this may pertain to ventilation in gastronomy or air heat exchangers of a partially heated production hall.

For smaller air heating ratios, the buffer storage tank is to be set for 30 minutes minimum runtime (of the boiler) and for larger proportions to 40 minutes (see chapter 10.3 "Dimensioning"). The boiler start can take place with the temperature sensor in the center of the buffer, so that the upper buffer half always maintains sufficient energy for the air heating and the lower buffer half allows a minimum of 15 minutes runtime for the boiler.

Buffer storage tank to cover peak loads

The buffer storage tank serves to cover peak loads, such as, for example, for a spray booth which is only in operation a few hours a day (for example in a car workshop or a carpentry). Here, a buffer storage tank can drastically reduce the required boiler output. To really maintain peak load, the charging status of the buffer is to be set high enough.

To cover smaller heating water quantities and thus also with a smaller buffer, lower return temperatures are required from the heating. That is why the air heat exchanger should be used at a design temperature of 80/40 °C, even better 60/40 °C instead of today's still unfortunate 80/60 °C (see the calculation in chapter 10.3 "Dimensioning").

Output peaks in the morning

For pure air heat exchangers in production halls, a buffer storage tank is to be considered for the morning start (between 30 and 60 minutes minimum runtime of the boiler, see calculation 10.3 "Dimensioning"). The buffer is not absolutely necessary if heating is started one or two hours before starting work.

In a well-insulated new build, a substantial drop at night is hardly possible any more and also makes no sense. Even for old builds, in particular for underfloor heating, the room temperature overnight should not drop by more than 3 °C below the daytime room temperature in order to prevent cooling of the walls. Regardless of the type of heating system, walls that have cooled overnight need a higher air temperature in the morning.

Comfort in a room is provided by the average of the air temperature and the surface temperature of the walls. This average should be between 19 and 21 °C. In winter, when heating is stopped, the surface temperature of poorly insulated outer walls can drop below 12 °C overnight. With 33% outer wall ratio, an air temperature above 24 °C is required in the morning for a "comfortable" room climate.

For comfortable heating, no buffer storage tank is needed in the morning if a minimum temperature is maintained overnight and the heating start is set one hour before getting up.

Integration of a solar heating system

Solar excesses which the hot water tank can no longer accommodate can be stored in a buffer for rainy days. If underfloor heating is present, with larger solar heating systems it makes sense to switch the collectors from hot water tank to underfloor heating in winter. At 50 °C effective temperature, the yield from solar collectors falters to "zero" in winter. At 30 °C for underfloor heating, simple flat plate collectors still achieve 30 to 40% efficiency in the transition period, and on clear, sunny spring days 50% collector efficiency is not uncommon at low temperature levels.

Solar coupling can be realised most elegantly with a buffer storage tank. To do this, a heating boiler, radiator and a hot water tank are connected to the upper half of the buffer, the solar heating system below the middle of the buffer and underfloor heating in the lower area of the buffer. The temperature sensor for the lower buffer area (for ending the charge by the boiler) is to be set above the solar heating system connection.

Tight radiator valves improve buffer utilisation

For radiators, low return temperatures and thus better buffer utilisation are also possible if they are fitted with tight radiator valves (kv < 0.35). Tight radiator valves are common for heating systems supplied with district heat, they get condensing boilers to really condense, and they control the room temperature more precisely with a higher valve authority.

Unfortunately, radiator valves are still delivered only with valve cores between kv=0.6 and kv=1.1 in order to ensure high return temperatures for oil boilers. Tighter kv values are currently only available via special order. It is frequently stated that valve cores can be throttled. However, this ignores the fact that if throttling from kv=1 to kv=0.35, the control area of the

valve is also drastically cut. Instead of controlling the room temperature, an "on/off" operation occurs with large temperature fluctuations.

If you fit radiators designed for 70/55 °C with tight valves, 80/45 °C operation is possible, whereby the flow temperature high point of 80 °C is only necessary on a few winter days.

If you want to keep the "maximum 60 °C flow temperature" guideline, select radiators from the 55/45 °C lists, then theoretically 65/35 °C is possible with tight valves. With the uncertainty factors, often minor over-dimensioning, 60/30 °C is then reached in actual operation. Temperatures below 30 °C are hardly reachable with a radiator, as below this temperature the convection (=heat transfer) breaks down significantly.

Even for existing radiator heating, equipping with tight radiator valves makes sense especially if the building envelope were subsequently insulated and therefore the radiators are large enough in current state. If a valve has to be exchanged, all valves must be exchanged. Because remaining old valves continue to keep the return temperature high.

With tight valves, not only will better buffer utilisation be achieved as a result of lower return temperatures, but the sharper control characteristic also provides better room control and thus energy-savings with simultaneous higher usage comfort.

Buffers for multi-boiler systems

For systems with several boilers and also for those with several very different heating circuits (especially different times of operation or air and underfloor heating in the same heating system), a bypass is needed between heat producers and consumers to ensure stable hydraulic conditions for the individual circuits. A hydraulic bypass is nothing more than a pipe connection between the flow and the return with the same diameter as both. The differential water quantities from heating and boiler circuits flow through this bypass, This results in a neutral pressure point that ensures that the heating circulation cannot influence the boiler water circulation and vice versa.

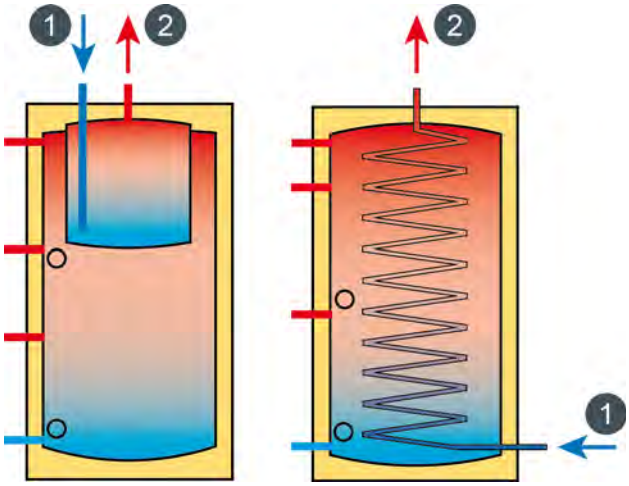
A bypass that can do more than just stabilise pressure conditions is the buffer. If a wood boiler for the base-load range and an oil/gas boiler for peak load or as emergency reserve are operated together in a heating system, a buffer storage tank reduces the operating time of the peak-load boiler by compensating for brief differences between production and consumption. The number of boiler starts/stops when consumption fluctuates around the rated output of a boiler is reduced, saving energy and easing stress on the boiler.

To work as an output compensator and bypass for several boilers, the buffer's storage capacity should be chosen to match 20 to 30 minutes of full-load operation for the largest automatic wood boiler in the system. In special cases, peak loads and non-continuously operated air heating systems must also be taken into account, or the morning peak if the start of an oil/gas boiler is to be avoided. Whereby "first", the morning peaks themselves should be minimised with staggered starting times for the heating circuits as well as reasonable set-back temperatures.

10.2 Hot water production

Hot water production in buffer

Here, two different systems are offered. Either a hot water tank suspended in the buffer or an internal water heat exchanger from bottom to top through the buffer.



1 Cold water

2 Hot water

The benefit of a hot water tank suspended above is the large amount of hot water for several parallel tapping points. A disadvantage is the cooling of the buffer from above, and thus a substantial reduction of the producible hot water quantity from a buffer charge.

For the internal water heat exchanger, the arguments are the exact opposite. Only a limited hot water quantity is produced, but with better buffer utilisation.

The advantage of both systems is the space saved by being able to forego the hot water tank. The disadvantage is calcification in case of hard drinking water. Above 15 °dH, these systems should only be deployed if the buffer temperature can be limited to 65 °C.

Hot water production with a fresh water module

Instead of a hot water tank, a drinking water heat exchanger (=fresh water module) is also possible, which heats fresh water at the time it's needed with the heating water of the buffer.



Fig. 10-1: Buffer storage tank with fresh water module

The fresh water module has significant advantages:

- The fresh water module can be installed on or next to the buffer. The space needed by the fresh water module is much less compared to a hot water tank.
- The temperature of the heating water in the fresh water module is limited to 60 °C with the integrated admixing pump. As a result of this, the critical calcification temperature of 60 °C is not reached and lime buildup is minimised.
- The buffer storage capacity is used to its maximum. Hot water is removed from the top and returned to the buffer below at 10 to 15 °C above the cold water flow temperature. The entire buffer volume is used with a maximum spread of 85/30 °C.

10.3 Dimensioning

Calculating the required buffer volume

First, the heat quantity to be stored "Q" is determined and, in a second step, the buffer volume required for this heat quantity.

Determine the heat quantity to be stored

Heat quantities are determined by the minimum runtime of the boiler. The formula for this is as follows:

$$Q_{min} = P_k \cdot t_{min}$$

$Q_{min.}$	...	Heat quantities from the minimum runtime of the boiler in [kWh]
P_K	...	Boiler output in [kW]
$T_{min.}$	...	Min. runtime in [h]

Example:
For a 90 kW boiler with 0.5 h minimum runtime, this results in:

$$Q_{min} = 90 \cdot 0{,}5 = 45\ kWh$$

Heat volume due to the peak heat load

The amount of thermal energy for the peak load is similarly calculated. The formula for this is as follows:

$$Q_{SHL} = (P_{SHL} - P_K) \cdot t_{SHL}$$

Q_{SHL}	...	Heat volume due to the peak heat load in [kWh]
P_{SHL}	...	Peak heat load in [kW]
P_K	...	Boiler output in [kW]
t_{SHL}	...	Duration of peak heat load in [h]

For a peak heat load of 210 kW over 1.5 h for a boiler output of 90 kW, this results in:

$$Q_{SHL} = (210 - 90) \cdot 1{,}5 = 180\ kWh$$

The heat volumes to be stored (minimum runtime and peak heat load) are now determined for the boiler.

Determine required buffer volume

The formula for this is as follows:

$$V_P = (Q_{SHL} + Q_{min}) \cdot \frac{c}{(T_{VL} - T_{RL})}$$

V_P	...	Required buffer tank volume in litres [l]
c	...	specific heat capacity of water (1 kWh heating 860 l water by 1 °C)
t_{VL}	...	Boiler flow temperature in [°C]
t_{VL}	...	Boiler return temperature in [°C]

Example:
The required buffer volume for the heat quantity from the minimum runtime of the boiler (45 kWh, see previous calculation) at 85 °C flow and 55 °C return temperature results in a value of:

$$V_P = (0 + 45) \cdot \frac{860}{(85 - 55)} = 1290\ l$$

Example:
For the peak heat load of 180 kWh (see previous calculation) at 85 °C flow and 60 °C return temperature from a conventional air heat exchanger (80/60 °C), and 45 kWh heat volume (from the minimum runtime), this results in a required buffer volume of:

$$V_P = (180 + 45) \cdot \frac{860}{(85 - 60)} = 7740\ l$$

The same peak heat load but with 40 °C return temperature from the air heat exchanger (80/40°C) results in:

$$V_P = (180 + 45) \cdot \frac{860}{(85 - 40)} = 4300\ l$$

Heat quantity for hot water

The formula for this is as follows:

$$Q_{WW} = n \cdot N \cdot \frac{(T_{WW} - T_{KW})}{c}$$

Q_{HW}	...	Heat quantity for hot water demand in [kWh]
n	...	Number of people
n	...	Standard consumption of hot water: • simple demand: 30 l/day with 45 °C • medium demand: 50 l/day with 45 °C • high demand: 80 l/day with 45 °C • a bathtub: 200 l with 40 °C • a shower: 50 l with 40 °C; flow rate 10 l/min with 40 °C
t_{HW}	...	Hot water temperature in [°C]
t_{kW}	...	Cold water temperature in [°C]

Examples:
For a family of four with medium demand, a heat volume for hot water is calculated as:

$$Q_{WW} = 4 \cdot 50 \cdot \frac{(45 - 10)}{860} = 8{,}1\ kWh$$

For a gymnasium with six showers (10 l/min) and 20 minutes shower duration, this results in:

$$Q_{WW} = 6 \cdot 10 \cdot 20 \cdot \frac{(40 - 10)}{860} = 41{,}8\ kWh$$

For the arrival of a bus at a hotel, it can be assumed that 60 people all take a shower (50 l/person) at the same time. This results in:

$$Q_{WW} = 60 \cdot 50 \cdot \frac{(40 - 10)}{860} = 104{,}6\ kWh$$

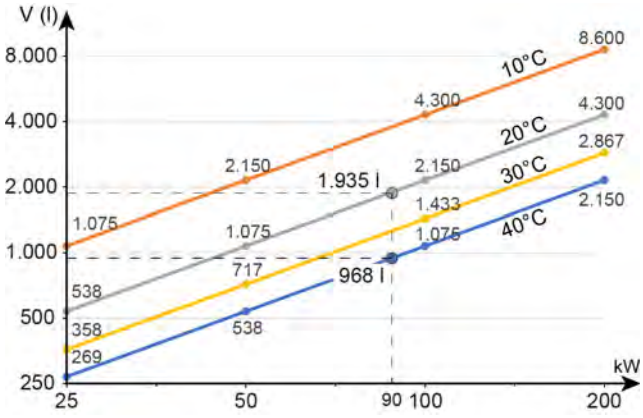
For the previous example with 104.6 kWh (heat volume for hot water) and 45 kWh (heat volume from the minimum runtime), this results in a required buffer volume of:

$$V_P = (104{,}6 + 45) \cdot \frac{860}{(85 - 40)} = 2859\ l$$

Choosing buffer size for systems with automatic fuel supply

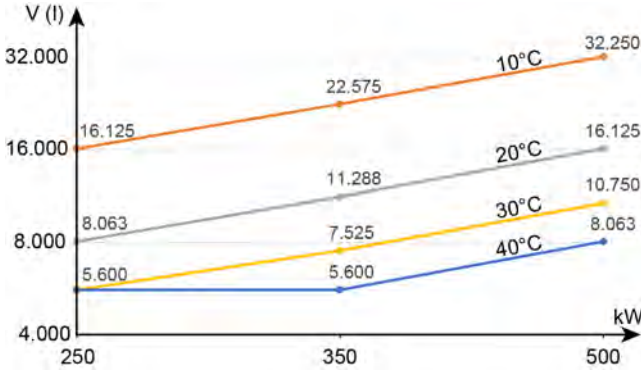
Even if some subsidy guidelines demand "litres per kilowatt" and thereby specify a minimum buffer size, one should arrange for a technically correct size. The storage capacity of a buffer essentially depends on the spread between the heating system's boiler flow temperature and return temperature.

Example: For a 90 kW boiler with 70°C flow temperature, 30 minutes of full-load operation with underfloor heating and 30°C return temperature (= 40°C spread) requires a buffer volume of 968 litres, but with radiator heating and 50°C return temperature (= 20°C spread), it requires 1,935 litres.



The minimum volume for the buffer can also be calculated with the following formula:

$$\text{Volume} = \frac{\text{operating time (h) x output (kW) x 860}}{\text{spread (°C)}}$$



10.4 Hydraulic integration

Hydraulic integration of a buffer

For the largest possible buffer storage capacity and for maximum solar yield even in winter, low return temperatures from the consumers are the goal.

Even the best stratified buffer can't unmix what has been mixed by heat distributors. Particularly in houses where radiators and underfloor circuits are present, no mixing heat distributors should be installed; the returns should be connected directly to the buffer. An underfloor heating system can still be operated with the return from radiators.

If a solar heating system is connected, only the cold returns from an underfloor heating system or from a fresh water module may be fed into the solar-heated lower third of the buffer. This results in lower solar panel working temperatures with significantly higher efficiencies and also significantly higher solar yield.

In all cases, an oil or gas boiler should be connected at the top part of the buffer only.

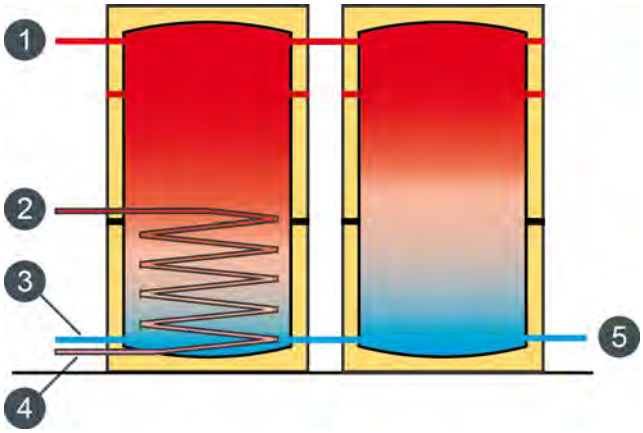
Siphon loops downwards at all connections reduce heat losses in summer.

10.5 Connection between multiple buffer storage tanks

Parallel connection

When there are several buffers, parallel connection (top with top and bottom with bottom) is usually the better solution. With a parallel connection, the entire buffer volume is available to installed heat exchangers such as solar heat exchangers or internal water heat exchangers and suspended hot water tanks.

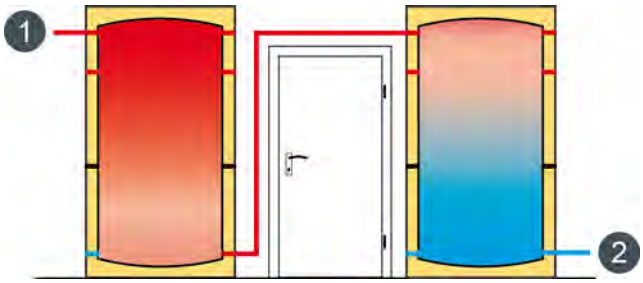
If two buffer storage tanks of different dimensions are connected in parallel, then the flow must be connected to the higher buffer or the lower buffer must be raised so that the upper connection can be horizontal.



1 Flow
2 Solar heating system flow
3 Return
4 Solar heating system return
5 Return

Serial connection

A serial connection between two buffers has no advantages over a parallel connection; but it does disadvantages. For example, a suspended hot water tank can get no heat from the second buffer or an internal heat exchanger cannot heat to both buffers. For this reason, with serial buffers one should connect the solar heating system using either heat exchangers in both buffers or (preferred) with an external heat exchanger.



1 Flow
2 Return

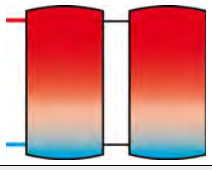
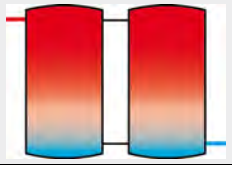
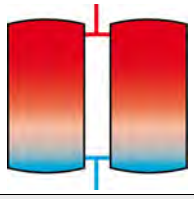
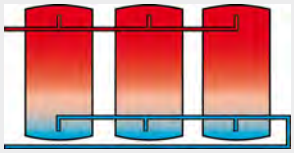
With rare exceptions, the use of the serial connection (buffer 2 top and buffer 1 bottom connected) is limited to overcoming spatial constraints of a particular installation. If passage to a door must be kept free or if there is a long distances between buffers, only a serial connection will be possible

Tichelmann connection for higher outputs

For parallel connection with one-sided connection, the volume of the second buffer is integrated using the thermosiphon principle. The exchange between the two tanks is driven only by gravity and limited by the hydraulic resistance of the junctions. Therefore, a Tichelmann connection is required for medium outputs.

With a 6/4" connection, a maximum of 5500 l/h at 0.25 mws pressure loss is possible (for flow and return connections together). This corresponds to 130 kW at a spread of 20 °C. Therefore, external piping (either symmetric or with Tichelmann connection), is needed for higher outputs.

With more than two tanks, external piping with Tichelmann connection is also needed to fill and drain all tanks uniformly.

Parallel connection between buffer storage tanks	**Buffer connections 5/4" DN 32**	**Buffer connections 6/4" DN 40**
one-sided connection 	< 25 kW boiler output maximum 2 buffers	< 40 kW boiler output maximum 2 buffers
Internal Tichelmann connection 	< 80 kW boiler output maximum 2 buffers	< 130 kW boiler output maximum 2 buffers
Symmetrical connection 	> 80 kW boiler output maximum 2 buffers	> 130 kW boiler output maximum 2 buffers
external piping with Tichelmann connection 	> 80 kW boiler output, and/or more than 2 buffers	> 130 kW boiler output, and/or more than 2 buffers

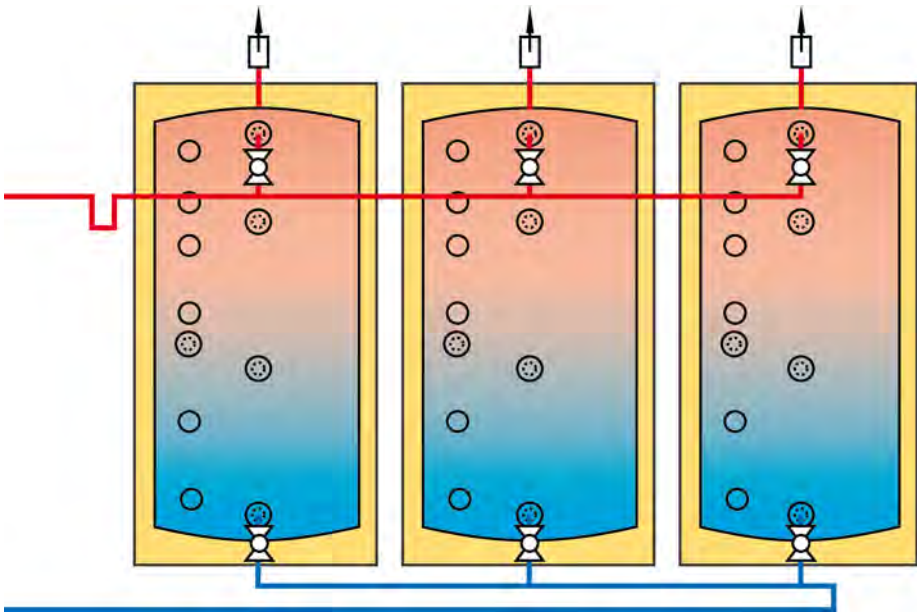
10.6 External Tichelmann

Parallel buffer connection with external Tichelmann

The basic principle of the external Tichelmann is parallel flow through several buffer storage tanks, which is achieved with diagonally opposed connection of the collectors. The last buffer on the flow collector is the first on the return collector. To achieve uniform charging and discharging, the connection pipes should be at least one or two sizes smaller than the collector. There is no output limit for this circuit. To minimize pipe circulation losses, it is helpful to make the connections with downward siphon loops.

For a small solar heating system, the total volume can be reduced in the summer by locking individual buffers.

maximum total output	Connecting ball valves on buffer	Collector line at least		
30 kW	DN 20	DN 25	R 1"	28x1.5
60 kW	DN 25	DN32	R 1¼"	35x1.5
90 kW	DN 32	DN 40	R 1½"	42x1.5
160 kW	DN 32	DN 50	R 2"	54x1.5
300 kW	DN 40	DN 65	R 2½"	76x2
450 kW	DN 40	DN 80	R 3"	89x2



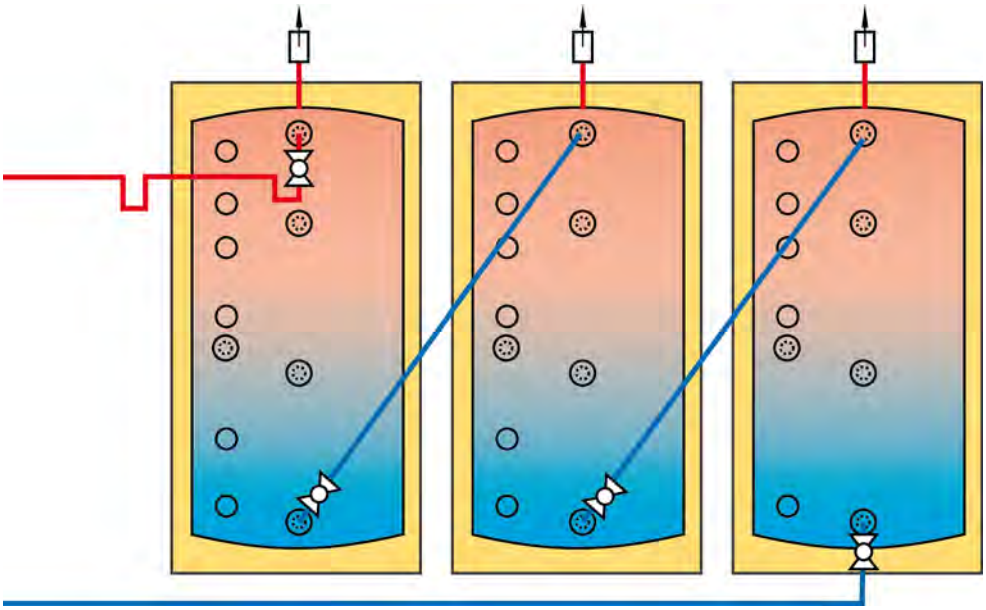
10.7 Serial buffer connection

Serial buffer connection

If there are different buffer types, or if not all buffers can be set up in one group, serial connection of the buffers will be necessary. Note that for serial buffer connection, integration of a solar heating system will work adequately only when a fresh water module is used for the hot water supply.

Solar tanks with internal solar exchangers are only of limited effectiveness. Combination tanks with immersed hot water tanks or internal water heat exchangers are unsuitable for a serial buffer connection. To minimize pipe circulation losses, it is helpful to make the connections with downward siphon loops.

maximum total output	Number of buffers	Connecting line, minimum		
30 kW	4	DN 25	R 1"	28x1.5
50 kW	4	DN32	R 1¼"	35x1.5
65 kW	2	DN32	R1¼"	35x1.5
80 kW	4	DN 40	R1½"	42x1.5
100 kW	2	DN 40	R1½"	42x1.5
140 kW	4	DN 50	R2"	54x1.5
170 kW	2	DN 50	R2"	54x1.5

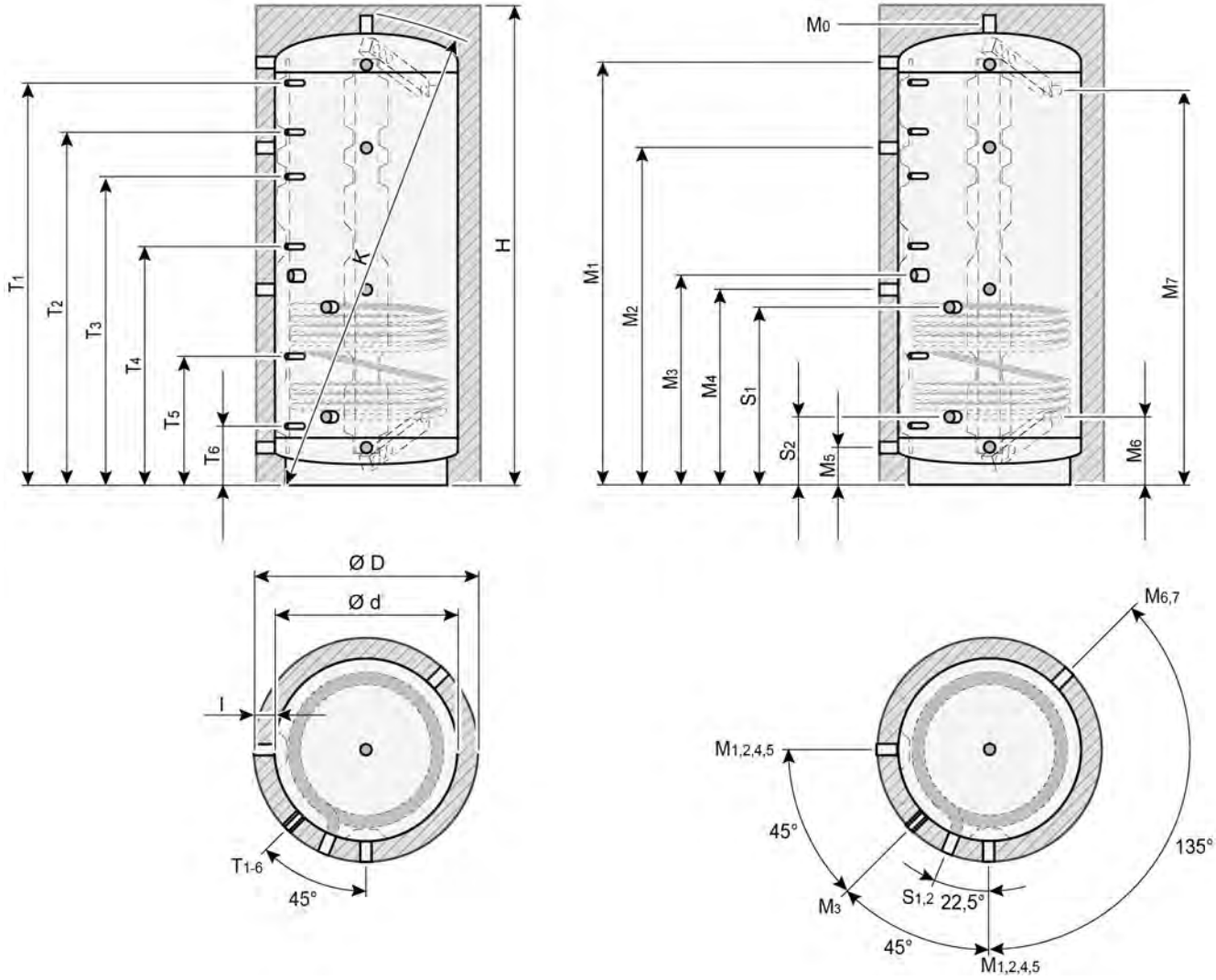


10.8 Technical data

10.8.1 Stratified buffer SP and SPS 600-2200

The M_3 connection without thermosiphonic separator is intended for the return connection of boilers that are to heat only the upper half of the buffer, or for the attachment of an electric heating element with a 6/4" outside thread.
The M_4 connection is designed specifically for the return from hot water tanks. By means of the separator plate, a warm return flows to the middle of the buffer and a cold return to the lower third.
The M_6 and M_7 connections are only installed on stratified buffers SP and SPS 2200. These connections are equipped with an inflow lance for high outputs with a flow rate of up to 20 m³/h.

The following figures show a solar SPS stratified buffer with a supplemental solar heat exchanger (connections S_1 and S_2).



Technical data

Technical data	Unit	SP/SPS 600	SP/SPS 825	SP/SPS 1000	SP/SPS 1100	SP/SPS 1650	SP/SPS 2200
Volume	l	600	825	1000	1100	1650	2200
Maximum permissible operating pressure	bar	3					
Maximum permissible operating temperature	°C	95					
Total weight (without solar heat exchanger)	kg	117	141	160	166	274	328

Technical data

Technical data		Unit	SP/SPS 600	SP/SPS 825	SP/SPS 1000	SP/SPS 1100	SP/SPS 1650	SP/SPS 2200
Diameter d	Diameter (without insulation)	mm	700	790	790	850	1000	1150
K	Tilted height (without insulation)	mm	1810	1970	2240	2200	2420	2430

For some storage tanks, the insulation is available with different energy efficiency indices. See the tables below.

Insulation with energy efficiency index "B"

Technical data		Unit	SP/SPS 600	SP/SPS 825	SP/SPS 1000	SP/SPS 1100
Energy efficiency index [a]			B			
Energy efficiency calculation factor [a]			0.83			
Heat retention loss [S]		W	85.4	96.7	104.6	108.3
Thermal conductivity of the insulation (lambda value)		W/mK	0.032			
I	Insulation thickness	mm	120			
Diameter d	Diameter (with insulation)	mm	940	1030	1030	1090
H	Height (with insulation)	mm	1830	1970	2250	2180

a. The values only apply for the combination of ETA SP/SPS stratified buffer storage and insulation ETA SP/SPS NeodulPlus (product information required according to EU Regulation 814/2013)

Insulation with energy efficiency index "C"

Technical data		Unit	SP/SPS 600	SP/SPS 825	SP/SPS 1000	SP/SPS 1100	SP/SPS 1650	SP/SPS 2200
Energy efficiency index [a]			C					-
Energy efficiency calculation factor [a]			0.83					-
Heat retention loss [S]		W	112.5	120.8	125	133.3	162.5	-
Thermal conductivity of the insulation (lambda value)		W/mK	0.032					
I	Insulation thickness	mm	100					
Diameter d	Diameter (with insulation)	mm	900	990	990	1050	1200	1350
H	Height (with insulation)	mm	1800	1940	2220	2150	2370	2380

a. The values only apply for the combination of ETA SP/SPS stratified buffer storage and insulation ETA SP/SPS NeodulPlus (product information required according to EU Regulation 814/2013)

Position height of the couplings and immersion sleeves

Position height		Unit	SP/SPS 600	SP/SPS 825	SP/SPS 1000	SP/SPS 1100	SP/SPS 1650	SP/SPS 2200
M_0	6/4" coupling	top						
M_1		mm	1595	1718	1998	1910	2095	2080
M_2		mm	1240	1393	1513	1535	1710	1735

Position height of the couplings and immersion sleeves

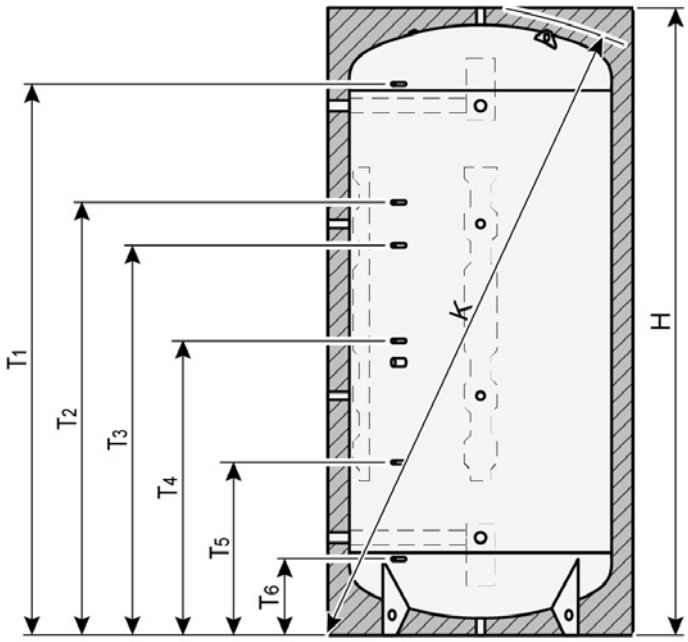
Position height		Unit	SP/SPS 600	SP/SPS 825	SP/SPS 1000	SP/SPS 1100	SP/SPS 1650	SP/SPS 2200
M_3	6/4" coupling (without separator plate)	mm	865	833	943	940	1020	1100
M_4	6/4" coupling	mm	800	773	883	875	940	965
M_5		mm	125	148	148	170	205	230
M_6	2" coupling	mm	-	-	-	-	-	360
M_7		mm	-	-	-	-	-	1970
T_1	Immersion sleeve ø 9 mm (for temperature sensor)	mm	1510	1628	1908	1820	2005	1985
T_2		mm	1340	1493	1613	1635	1810	1835
T_3		mm	1140	1293	1413	1435	1610	1635
T_4		mm	965	933	1043	1040	1120	1200
T_5		mm	525	503	547	565	625	690
T_6		mm	230	253	253	275	310	325

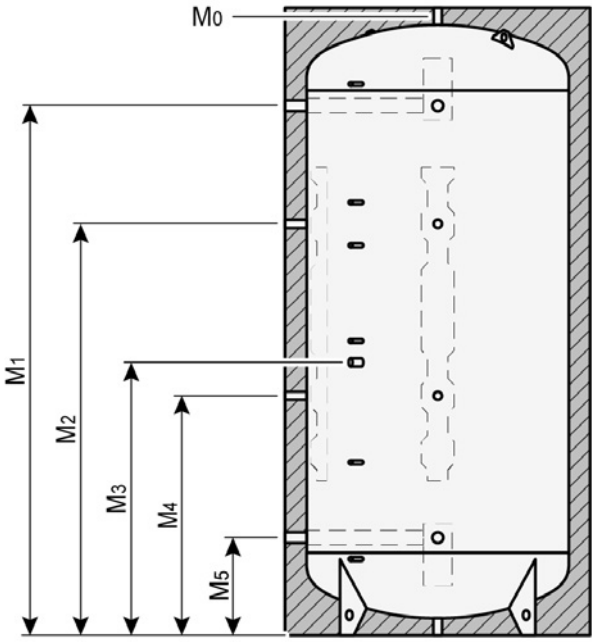
Supplementary data for Solar SPS stratified buffer

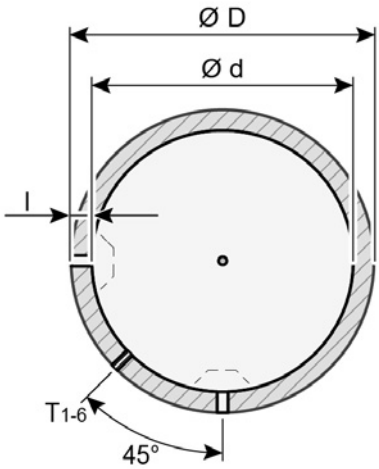
Technical data	Unit	SPS 600	SPS 825	SPS 1000	SPS 1100	SPS 1650	SPS 2200
Optimum solar collector area (in relation to tank volume)	m²	3-7	4-9	5-11	6-12	8-18	11-25
Maximum solar collector area (as regards solar exchanger)	m²	15	15	18	20	25	30
Maximum permissible operating pressure (solar exchanger)	bar	16					
Maximum permissible operating temperature (solar exchanger)	°C	110					
Total weight (with solar heat exchanger)	kg	157	182	206	213	338	409
Solar exchanger surface	m²	2.5	2.5	2.9	3.2	4.0	5.1
Volume of solar heat exchanger	l	15.5	15.5	18.0	20.0	25.0	33.9
Pressure loss at 1000 l/h	mws	0.31	0.31	0.36	0.39	0.49	0.61

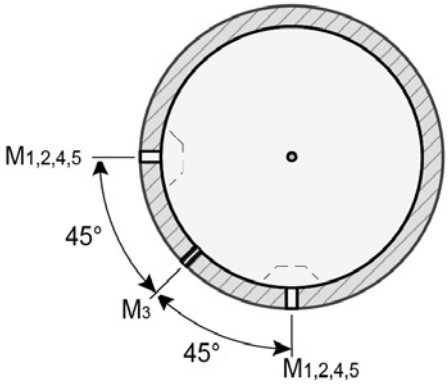
Position height		Unit	SPS 600	SPS 825	SPS 1000	SPS 1100	SPS 1650	SPS 2200
S_1	R1" coupling (solar exchanger connection)	mm	818	757	841	863	940	1032
S_2		mm	230	253	253	275	310	360

10.8.2 Buffer storage SP 3000 - 5000









Technical data		Unit	SP 3000	SP 4000	SP 5000
Volume		l	3,000	4,000	5,000
Maximum permissible operating pressure		bar	3	3	3
Maximum permissible operating temperature		°C	95	95	95
Total weight		kg	397	477	582
Colour of the insulation			Melon yellow		
I	Insulation	mm	100	100	100
Di-am-eter D	Diameter (without insulation)	mm	1,250	1,400	1,600
Di-am-eter D	Diameter (with insulation)	mm	1,450	1,600	1,800
H	Height (with insulation)	mm	2,712	2,920	2,850
K	Tilted height	mm	2,740	2,950	2,890

Position height		Unit	SP 3000	SP 4000	SP 5000
M_0	6/4" coupling	top			
M_1	2" coupling	mm	2,286	2,465	2,355
M_2	6/4" coupling	mm	1,811	1,915	1,880
M_3	6/4" coupling (without separator plate)	mm	1,176	1,300	1,245
M_4	6/4" coupling	mm	1,041	1,145	1,110
M_5	2" coupling	mm	426	455	495
T_1	Immersion sleeve ø 9 mm (for temperature sensor)	mm	2,386	2,565	2,455
T_2		mm	1,911	2,015	1,980
T_3		mm	1,711	1,815	1,780
T_4		mm	1,276	1,400	1,345
T_5		mm	766	835	835
T_6		mm	326	355	395

11 Information on fuel

Wood: old, but good

Wood is our oldest fuel - and our most modern: There is a lot of history in-between open fires in front of caves and modern biomass boilers. In the middle of the 20th century, the number of wood heating systems fell briefly. Oil was the new heating hype. A brief interlude in comparison to the consistency of wood. Today, we know that heating with fossil fuel has no future. It contributes to global warming and harms the environment. Supply security is not guaranteed long term also, as fossil fuels are diminishing, don't regrow, and sometimes come from politically unstable regions. While wood in contrast is a cheaper, domestic, renewable raw material that does not pollute the climate when burnt. No wonder that heating with wood is booming!



The fuels are offered as quality-controlled branded products. In principle, the following quality standards are exist:

- Wood chips according EN ISO 17225-4:2014, quality classes A1/A2/B1/B2, size P16S-P31S, maximum water content 35% (M35)
- Wood pellets according EN ISO 17225-2:2014, quality class A1, ENplus-A1
- Shavings and swarf briquets according EN ISO 17225-3:2014, quality classes A1/A2/B
- Miscanthus-wood chips according ÖNORM C 4000 and C 4001
- In Germany: fuel classes 4/5a according 1. BImSchV. Use fuel classes 5/6/7/8 only after consultation with ETA.

They are suitable for fully automated heating operation. Even the pollutant content is limited by very strict values. This means it is safe to use the ash as fertiliser in the garden.

Wood chips are a safe and environmentally-friendly alternative to fossil fuels such as oil and gas.

Energy content of different fuels	
Extra-light heating oil	10.00 kWh/lt

Energy content of different fuels	
Natural gas	9.52 kWh/m³
LPG	12.8 kWh/kg or 6.78 kWh/lt
Coke	8.06 kWh/kg
Pellets	4.90 kWh/kg
Split spruce logs	1250 kWh/rm
Split logs beech/oak	1800 kWh/rm
Spruce wood chips w=15% G30	850 kWh/srm
Wood chips beech/oak w=15% G30	1220 kWh/srm

11.1 Suitable fuels

The amount of ash depends on the fuel

Ash is the non-flammable residue from the wood. It consists of minerals such as calcium and potassium without which life cannot exist, but also soil, sand and stones, i.e. impurities in the fuel.

Wood chip, with its very low bark content, has an ash content of approximately 0.5 %. The bark itself has an ash content of nearly 4 %. In practice, there is always soil and sand stuck to the bark.

Fuel from crops has a very high potassium content. The ash content is in the range 3 to 6%.

Wood residues with a high proportion of fine branches and needles is extremely dense in storage, is poorly ventilated and does not dry. Frequently, this material already begins to rot at the timber storage site. With this process of decomposition, the heating value diminishes and the ash content rises.

How often ash waste containers have to be emptied depends on the heat capacity of the boiler and the quality of the fuel (ash content, heating value, etc..).

The preferred fuel is coarse wood chips with a low fine content

The length of the individual wood chips should be between 30 and 50 mm, to ensure that air can circulate well among the stored chips, water can escape from the pile and the tendency to rot and turn mouldy is minimal.

If the fine content (sawdust, bark, needles, soil, sand) is too high, it can obstruct the airways. Water evaporates inside the warm wood chip pile. If the

vapour cannot escape, it will condense in the upper part of the heap. Some of the wood chips will then rot and turn to compost with no heating value.

Avoid green, moist wood chips

Only wood chips that are sufficiently dry (water content below 25%) can be stored in a concrete bunker without problems. Moist, coarsely chopped chips stored in an open hall exposed to the wind quickly reach a water content under 35%.

Be especially careful with waste wood

When waste wood is on offer, it may be rotten with no heating value; only buy waste wood by weight and with limited water content (25% maximum). Also ensure that the wood contains no contaminants. The applicable laws only allow the use of untreated wood without foreign substances for heating purposes.

Wood-processing facilities may burn chipboard if it contains no halogens or wood preservatives.

Binding agents containing chlorine used to frequently be used in wood products. if these are burned in a boiler without appropriate cleaning of the flue gas, contaminants detrimental to health will be emitted. Apart from this, a very high chlorine content will have a severe negative effect on the life of the boiler.

Only burn wood products or painted, coated or varnished wood if you are sure these contain no wood preservatives, organohalogen compounds or heavy metals.

Nails and stones

Nails and stones will hardly bring the boiler to a halt, but they cause increased wear on the screws and the blades in the rotary valve.

Impurities in the fuel

Impurities in the fuel result in a higher ash content and are frequently responsible for a lower ash melting point. If the ash melting point is exceeded, the ash fuses (slag formation). It is therefore in the plant operator's interests to keep impurities to a minimum.

Types of wood chips

The best quality wood chips are finely chopped hardwood, without bark, with low dust content and a water content below 20%. With the highest heating value and the lowest storage volume requirement, this would be the optimum fuel for any boiler.

Fine wood chips can be made from dry wood, enabling a higher storage density.

Even if wood is stored dry, the energy content wanes, and the heating value of dry wood decreases by 10% over 10 years.

Wood chips from dry branches and shrubbery cuttings have higher bark content and usually also large amounts of dirt and decayed material. Resulting in more ash. If they were chopped from dry wood, there will be no storage problems and the reduction in boiler output is low.

Forest-chopped wood chips from fresh branches are not fit for storage and reduce the achievable boiler output significantly.

Wood that has been stored in damp conditions for a long time (10 years) has lost up to 50% of its heating value. Chips from such wood significantly reduce the achievable boiler output.

The final product from wet wood is compost, which can be disposed of in a refuse incinerator but can hardly be burned in a normal boiler. Ensure good ventilation during storage. The higher the water content of the wood, the more coarsely it should be chopped. Never store more than a year's supply of wood chips (round logs can be stored more easily and densely).

Be very careful where wood chips from waste wood are on offer at especially low prices; the fraction of decayed material and perhaps also the amount of foreign objects (nails, wood preservatives, sand, stones) can be very high.

11.2 Moist fuel

Decay and mould

Up to a water content of approx. 25%, the water is bound up in the wood fibres. Above 25%, water is found between the fibre cells in cavities and capillary vessels. This unbound water is a habitat for, and also a basis for the reproduction of, microbes and fungi, which can penetrate the tree through wounds in the wood structure, particularly cuts or breaks. These microbes convert cellulose and lignin into the basic building blocks carbon dioxide and water. The wood rots, hollows out and becomes brittle, ultimately losing all of its heating value.

When a tree is felled, the race between drying and decay begins. As the water content decreases, the living conditions for microbes worsen until they die off when the water content drops below 25%. The faster the drying process, the more heating value remains in the wood.

For thin branches, the microbes have a very large contact surface in relation to the wood volume. No matter how neatly the branches are stacked, losses in heating value over 25% are the rule (and considerably more in wet weather). This is why forestry businesses

don't even take part in this race when branches are smaller than 3 to 5 cm; instead, the material is left behind as nutrient material for the forest.

Easy recognition of moist or dry wood

Even through professionals who work daily with wood chips only trust the oven test for measurements of the exact water content, there is still a very simple way to distinguish moist from dry. Chips that feel dry in the hand have a water content below 25% and can be stored without problems. If they feel wet, the water content is sure to be above 35%.

If the wood chips are dark brown, light and already crumbly, then you are holding rotten wood in your hands, wood that has already lost the majority of its heating value. From such "compost" you can expect only problems, but not boiler output.

Do not store moist wood chips without ventilation

Wood chips can only be stored without ventilation (for example in a concrete cellar) if their water content is no more than 30%.

If moist wood chips from a sawmill are to be used anyway, then no more than three weeks' supply should ever be kept in an unventilated bunker. An air inlet and an outlet fan can remove water vapour and at least limit mould growth.

Store moist wood chips in an open hall

During the decay process, moist wood chips release heat that drives out water. Wet areas form on the surface, and rising water vapour may also be visible. If the wind is given the chance to transport the water away, coarse wood chips will dry while decay and fungi will stay within acceptable limits.

Best is a flying roof separate from living and working quarters, which keeps rain out but lets the wind work unhindered. At least one side of the storage hall should be completely open. Additional openings in all other walls improve the storage conditions.

11.3 Drying and chopping wood chips

Coarse wood chips with minimal fine content dry fastest

Coarse chips (chopped with sharp blades!!!) dry faster with less loss of material due to the improved air circulation. Fill heights between 4 and 6 m have proven effective. This height is also safe as regards self-ignition, which only becomes a danger at heights of 8 m or more.

Even when coarsely chopped, very moist and green material (leaves and needles) and bark have a high fine content (typical and unavoidable features of shrubbery cuttings and delimbing material) and higher biological activity, and allow only minimal air circulation. In spite of higher self-heating, the low air circulation slows the drying process and material loss is considerably higher.

Dry like hay on a hard surface

For your own use, spread out moist wood chips in a layer 10 cm thick on an asphalt or concrete surface on hot summer days. Good results can also be had on sunny autumn days if you turn the chips over several times. Two days are usually enough to attain a water content below 30%, making the chips fit for storage even under poor conditions.

Drying in a covered mesh enclosure

When building a new wood chip storage facility, roofed storage containers with mesh walls should be considered for air-drying of moist chips. A windy location is important. Southward orientation can help with drying even in winter. The height of the container depends on the height of the front end loader needed for filling. The lowest wall element must be removable to allow removal of the wood chips. The depth can be up to 2 m. Drying time is 4 to 8 months and a water content below 20% is attainable.

Artificial ventilation

In spite of a few elaborate pilot projects with solar energy, drying with heated air blown into the store via channels in its floor has not proven itself very economical thus far. The energy costs for drying often exceed the achievable increase in heating value.

Dry wood before chopping, fell in winter and chop in summer

It is much easier to dry the wood before chopping it. With interim storage before chopping in summer, a water content below 30% can be reached, ensuring problem-free storage for the wood chips.

The decision whether to dry entire trees, or trunks and branches separately depends largely on the accessibility of the forest and the harvesting methods. Here are a few tips for orientation:

- Well-ventilated piles, trunks with bark removed, or entire trees dry faster and better. Sun helps, and wind is indispensable for drying.
- Softwood should be felled no later than December and stored at least 50 m from the forest due to the risk of beetles.

- If the first regeneration felling is done for softwood in September, the wood will no longer be infested by beetles in the spring. It can be left in the forest without delimbing and chopped as entire trees in summer.

Leave green branches in the forest as nutrients

Leave green branches and treetops in the forest; as fuel they are only "air and water". As valuable nutrients, they should remain in the forest.

11.4 Water content

Using an oven to determine water content

A kilogram of wood chips is spread out on a baking sheet and dried in an oven for 6 to 12 hours at 101 to 104°C. To be certain of a temperature over 100°C in a typical electric oven in spite of the inexact thermostat, you can set it to 110°C, but no higher as the wood will begin outgassing even at slightly higher temperatures. Fine and very moist pieces will need to be turned a few times. The difference in weight between the moist test material and the dry material corresponds to the water content.

Longer interim storage of samples can falsify their water content.

Take samples after transport

A pile of wood chips has 10 to 30% more water content in the upper layers than in the middle. The material is mixed by the loading and unloading process during transport. By taking about a litre from 5 different places at a depth of at least 20 cm (never from the surface) in each load, you can get a good average with low error.

Taking the test quantity from the total sample

From several transport loads, you will get more than 1 kg of test material. To obtain a smaller quantity, mix the material by rebuilding the pile, always emptying the shovel over the top of the pile so that the material is distributed over its entire surface. Then flatten the pile and remove the two opposing quarters from it. Repeat the mixing and removal process until you have two batches of test material of 1 kg each, 1 kg for the buyer, who usually determines the water content in the oven, and 1 kg for the seller as a control sample. The volume for one kilogram is around 3 litres for wet, heavy wood chips and as much as 5 litres for very dry and light material.

Water content and moisture

Water content has become the established measurement for wood used for generating energy; in the lumber business, the wood's moisture is usually stated.

$$\text{Water content (\%)} = \frac{\text{water in the wood (kg)} \times 100}{\text{total weight of wood (kg)}}$$

$$\text{Moisture content (\%)} = \frac{\text{water in the wood (kg)} \times 100}{\text{dry weight of the wood (kg)}}$$

Converting moisture to water content

$$\text{Water content (\%)} = \frac{\text{moisture (\%)} \times 100}{100\% + \text{moisture (\%)}}$$

11.5 Judging the quality

Judging the quality	
Criterion	**Comments**
Ash content	Contaminated material burns poorly and is often a sign of decayed or dirty wood chips.
Large pieces	Fuel may contain individual, large pieces up to 20 cm long. They are cut by the blade in the rotary valve. The majority of wood chip pieces should not be longer than 5 cm to reliably prevent blockages in the fuel conveying system.
Dirt	Soil and sand cause slag formation on the grate and result in more effort spent on cleaning d ue to a lower ash melting point.
Green leaves and needles	A layer of chips from green branches with leaves or needles can cause a blockage in a pile of chips on which rising moisture condenses, resulting in decay and mould.
Metal, stones	Even though the boiler cannot be brought to a halt by nails and small stones, such foreign ma terials should be avoided in wood chips because they cause increased wear in the fuel conve ying system.

The base for the following tables are wood chips from spruce or alder, with a water content of 30% and size P16S.

Judging quality when buying in loose cubic metres			
Criterion	**Comments**	**Effect on energy content per loose cubic metre**	
Water content	The lower the water content, the higher the heating value. In addition, under a water content of 25% the wood shrinks. So a cubic metre with 20% water content, contains approx. 3% more wood than a cubic metre wi th 30% water content. The water content is given as a percent-age of the total weight.	20% 30% 35% 40%	+6% 0% -2,5% -4%
Chip size	The more finely the material is chopped, the more material fits in a cubic metre.	P16S P31S	+0% -16%
Kind of wood	Hardwood is denser and heavier and thus has a higher heat co ntent per cubic metre.	Hornbeam, black locu st	+53%
		Beech	+44%
		Oak, ash	+40%
		Birch, maple	+25%
		Pine, larch	+19%
		Spruce, alder	0%
		Fir, willow	-6%
		Poplar	-19%
Bark content	The lighter in colour the wood chips are, the lower their bark co ntent. Wood chips from small branches or wood chips with bark from sawmills have a high bark content with high ash content and u sually also higher dirt content. This results in more effort spent on cleaning.	without bark	+5%
		10% bark	0%
		30% bark	-10%
Small branches	Wood chips from small branches usually have a high degree of decay.	Small branches	-25%

Judging quality when buying by the kilogram			
Criterion	**Comments**	**Effect on energy content per kilogram**	
Water content	The lower the water content, the higher the heating value. The water content is given as a percentage of the total weight.	20% 30% 35% 40%	+12% 0% -12% -20%
Chip size	The chip size has no effect on the heating value per kilogram		
Kind of wood	Heavy hardwood, when dried, has about 5% less heating value than softwood, and about 6% less when moist. Light hardwood, when dried, has 6% less heating value than softwood and 7% less when moist.	Softwood Hardwood	0% -5% to -7%
Bark content	The bark content has little influence on the heating value per kilogram, but a high bark content means a higher ash content and more time spent on cleaning.		
Small branches	Wood chips from small branches usually have a high degree of decay.	Small branches	-25%

11.6 Other fuels

Other fuels	
Pellets	Pellets have a higher fuel density and can only be burned with flue gas recirculation. Pellets are always sold by weight. The heating value of hardwood pellets (4.60 kWh/kg) is about 6% less than that of softwood pellets (4.9 kWh/kg).
Miscanthus	The heating value is the same as for air-dried softwood; best bought by weight. Since its ash has a very low sintering point, flue gas recirculation is required to prevent slag formation. To reduce boiler corrosion, ensure that chlorine-free fertiliser (potassium sulphate instead of potassium chloride) is used. Regardless of whether it is chopped or made into pellets, miscanthus needs a very large combustion chamber, so for size 35/50 a maximum heating output of 35 kW can be reached, for size 70/90 a maximum of 63 kW, for size 130 a maximum of 95 kW and for size 200 a maximum of 140 kW.
Old wood	Wood kept in dry storage loses only the volatile components (about 10% of the heating value). Wood stored in moist storage decays (cold oxidation process) to the point of total loss of heating value.
Wood shavings	The heating value per cubic metre varies widely and is around 30 to 60% less than that of wood chips (with 30% water content) from the same wood. Since wood shavings are usually air-dried (15% to 20% water content), they are best bought by weight. Wood chips from some types of hardwood cause rapid wear on the combustion chamber's fire clay. With wood shavings, the full rated output of the boiler cannot be reached.
Sawdust	The heating value per loose cubic metre is between 25 and 50% less than that of wood chips (with 30% water content) from the same wood. Sawdust is best bought by weight, after determination of its water content. Dry sawdust from joineries can be burned, but not fresh (moist) sawdust from sawmills.
Chipboard	Chipboard waste can be used if it is free from formaldehyde and wood preservatives, and is not coated with PVC. However, this is only allowed with an official permit, which is usually only granted on a case-by-case basis to wood-processing facilities.
Demolition wood	Only wood that is free of halogens and wood preservatives may be burned. The fraction of rotten wood is often high, and the heating value low, and it is often contaminated with dust, metal and stones.

11.7 Heating value

Heating values of fuels

	Heating value based on weight		Cubic metre (rm) [a]				Loose cubic metre (srm) [b]							
			Logs				Wood chips P16S				Wood chips P31S			
			Weight		Heating value		Weight		Heating value		Weight		Heating value	
Water content	**15%**	**30%**	**15%**	**30%**	**15%**	**30%**	**15%**	**30%**	**15%**	**30%**	**15%**	**30%**	**15%**	**30%**
Unit	**kWh/kg**	**kWh/kg**	**kg/rm**	**kg/rm**	**kWh/rm**	**kWh/rm**	**kg/srm**	**kg/srm**	**kWh/srm**	**kWh/srm**	**kg/srm**	**kg/srm**	**kWh/srm**	**kWh/srm**
Softwood			1 rm = 0.65 fm [c]		1 rm = 0.56 fm [c]		1 srm = 0.40 fm [c]				1 rm = 0.33 fm [c]			
Fir	4.40	3.51	276	317	1210	1110	178	205	780	720	148	171	650	600
Spruce	4.49	3.58	293	337	1310	1210	189	218	850	780	157	181	710	650
Douglas fir	4.43	3.53	319	368	1410	1300	206	237	910	840	172	198	760	700
Pine	4.32	3.44	360	414	1550	1420	232	267	1000	920	193	223	830	770
Larch	4.27	3.39	370	426	1580	1450	239	275	1020	930	199	229	850	780
Hardwood			1 rm = 0.59 fm [c]		1 rm = 0.50 fm [c]		1 srm = 0.40 fm [c]				1 rm = 0.33 fm [c]			
Poplar	3.99	3.16	256	295	1020	930	174	200	690	630	145	167	580	530
Willow	3.76	2.97	320	369	1200	1100	217	250	810	740	181	208	680	620
Alder	4.06	3.23	313	361	1270	1160	212	245	860	790	177	204	720	660
Maple	4.04	3.21	384	443	1550	1420	260	300	1050	960	217	250	880	800
Birch	4.01	3.18	391	450	1570	1430	265	305	1060	970	221	254	890	810
Ash	4.10	3.25	429	494	1760	1610	291	335	1190	1090	242	279	990	910
Oak	4.10	3.25	429	494	1760	1610	291	335	1190	1090	242	279	990	910
Beech	4.13	3.28	435	502	1800	1640	302	347	1220	1110	251	289	1010	930
Robinia	4.11	3.27	467	538	1920	1760	317	365	1300	1190	264	304	1090	990

a. A cubic metre (rm) corresponds to 1 m³ layered logs (1 m length) with air gaps.

b. A loose cubic metre (srm) corresponds to 1 m³ of loosely dumped wood chips.

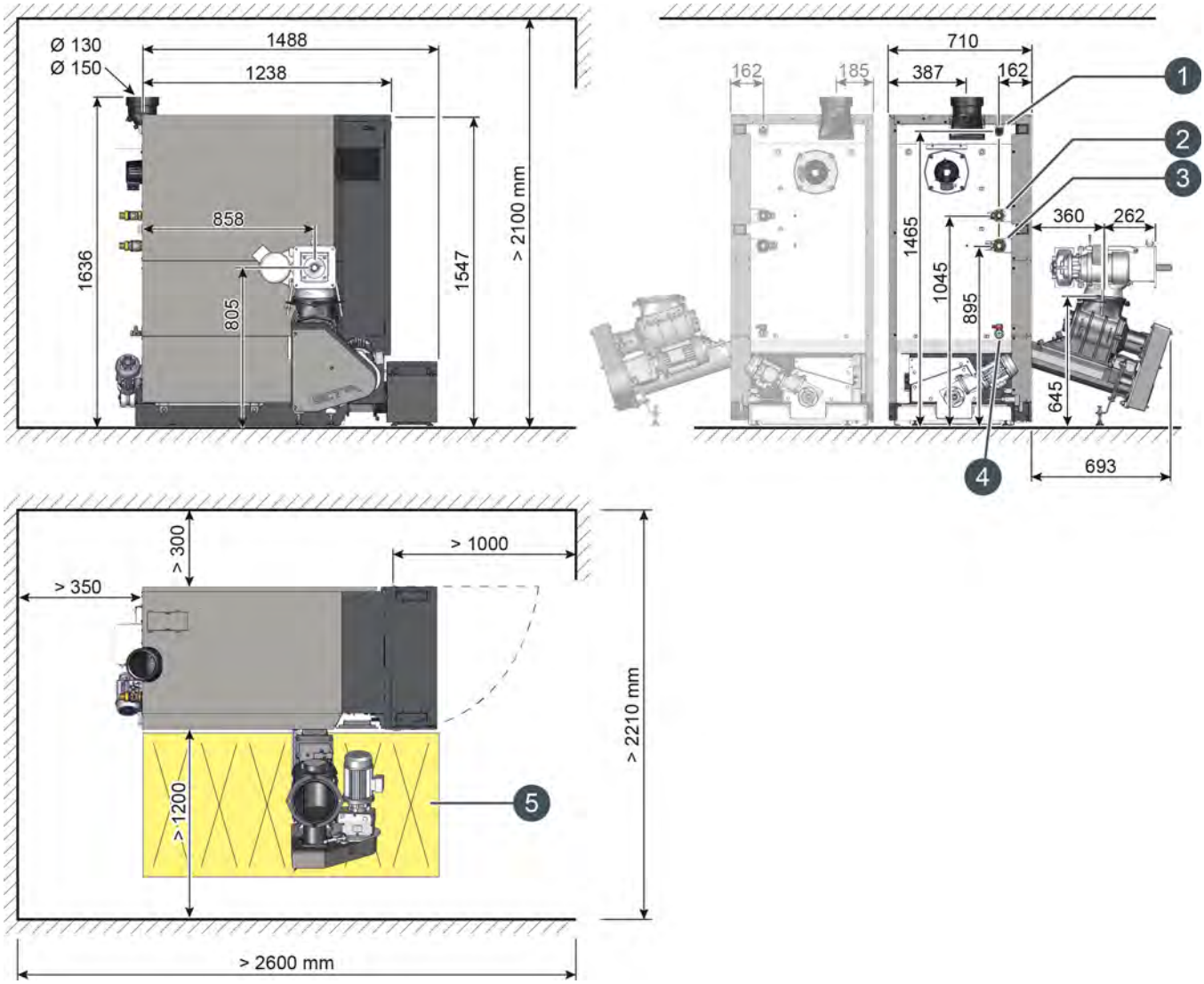
c. A solid cubic metre (fm) corresponds to 1 m³ wood without air gaps.

12 Technical data

12.1 eHACK 20-50 kW

eHACK 20-50 kW wood chip boiler

The boiler can optionally be supplied with the stoker on either the right or the left side. The illustration shows a boiler with the stoker on the left side.



1 Connection for safety valve, pressure gauge and bleed valve R1/2" internal thread
2 Flow, R5/4“
3 Return, R5/4“
4 Filling and draining valve
5 Maintenance area to be kept clear

For maintenance on the boiler, an area which is to be kept clear is required on the side of the boiler on which the conveying system (stoker) is mounted. The conveying system may not run through the maintenance area. Also, no expansion tanks or other devices may be installed in this area.

The flue gas connection on the boiler does not yet give any indication of the required chimney diameter. Information on the required chimney diameter can be found in the installation instructions for the boiler in the Chimney chapter.

Wood chip boiler	**Unit**	**20**	**25**	**32**	**45**	**50**
Rated capacity, wood chips M25 BD 150 (W25-S160)	kW	5.9 - 19.9	7.6 - 25.4	7.6 - 32	7.6 - 45	14.9 - 49.9
Rated capacity, pellets	kW	---	7.5 - 25.4	7.5 - 32	7.5 - 45	14.9 - 49.9
Efficiency with wood chips at partial / full load	%	91.2 / 94.0	92.9 / 94.6	92.9 / 94.6	92.9 / 94.7	93.3 / 94.7
Efficiency with pellets at partial / full load	%	---	93.4 / 94.6	93.4 / 94.3	93.4 / 93.7	93.4 / 93.6
Transport dimensions, W x D x H	mm	710 x 1430 x 1610				
Weight with / without rotary stoker	kg	830 / 712				
Water content	litres	153				
Available residual pump head (at ΔT = 20 °C) for buffer operation	mWs / m³/h	5.5 / 0.86	5.2 / 1.08	4.1 / 1.38	2.8 / 1.92	2.0 / 2.13
Ash box volume	litres	52				
Flue gas mass flow rate, partial / full load	g / s	4.6 / 12.7	5.4 / 14.8	5.4 / 19	5.4 / 25.2	5.6 / 27.8
CO_2 content in dry exhaust gas partial/full load	%	10.3 / 12.6	11.2 / 13.6	11.2 / 13.8	11.2 / 14.1	11.3 / 14.1
Exhaust temperature at partial / full load	°C	~80 / ~150				
Required flue draught	Pa	> 5 Pa A draught limiter is required above 15 Pa				
Carbon monoxide (CO) emissions with wood chips at partial / full load	mg/MJ	63 / 14	33 / 45	33 / 34	33 / 13	30 / 12
	mg/m³ (13% O_2)	93 / 21	49 / 67	49 / 51	49 / 19	45 / 17
Carbon monoxide (CO) emissions with pellets at partial/full load	mg/MJ	---	20 / 25	20 / 19	20 / 6	20 / 6
	mg/m³ (13% O_2)	---	30 / 38	30 / 28	30 / 8	30 / 8
Dust emissions with wood chips at partial / full load	mg/MJ	3 / 9	4 / 4	4 / 4	4 / 5	4 / 5
	mg/m³ (13% O_2)	5 / 13	6 / 5	6 / 6	6 / 7	6 / 8
Dust emissions with pellets at partial / full load	mg/MJ	---	7 / 3	7 / 3	7 / 3	7 / 3
	mg/m³ (13% O_2)	---	10 / 5	10 / 5	10 / 4	10 / 5
Unburned hydrocarbon emissions (CxHy) with wood chips at partial/full load	mg/MJ	2 / <1	2 / <1	2 / <1	2 / <1	<1 / <1
	mg/m³ (13% O_2)	3 / <1	2 / 1	2 / <1	2 / <1	<1 / <1
Unburned hydrocarbons (CxHy) with pellets at partial/full load	mg/MJ	---	1 / <1	1 / <1	1 / <1	<1 / <1
	mg/m³ (13% O_2)	---	2 / <1	2 / <1	2 / <1	<1 / <1
Electrical power consumption with wood chips at partial / full load (=values with integrated precipitator)	W	52 / 74 (72 / 94)	56 / 83 (76 / 103)	56 / 94 (76 / 114)	56 / 121 (76 / 141)	57 / 124 (87 / 154)
Electrical power consumption with pellets at partial / full load (=values with integrated precipitator)	W	---	44 / 63 (64 / 83)	44 / 71 (64 / 91)	44 / 84 (64 / 104)	46 / 92 (76 / 122)
Electrical power consumption in ready mode	W	12				

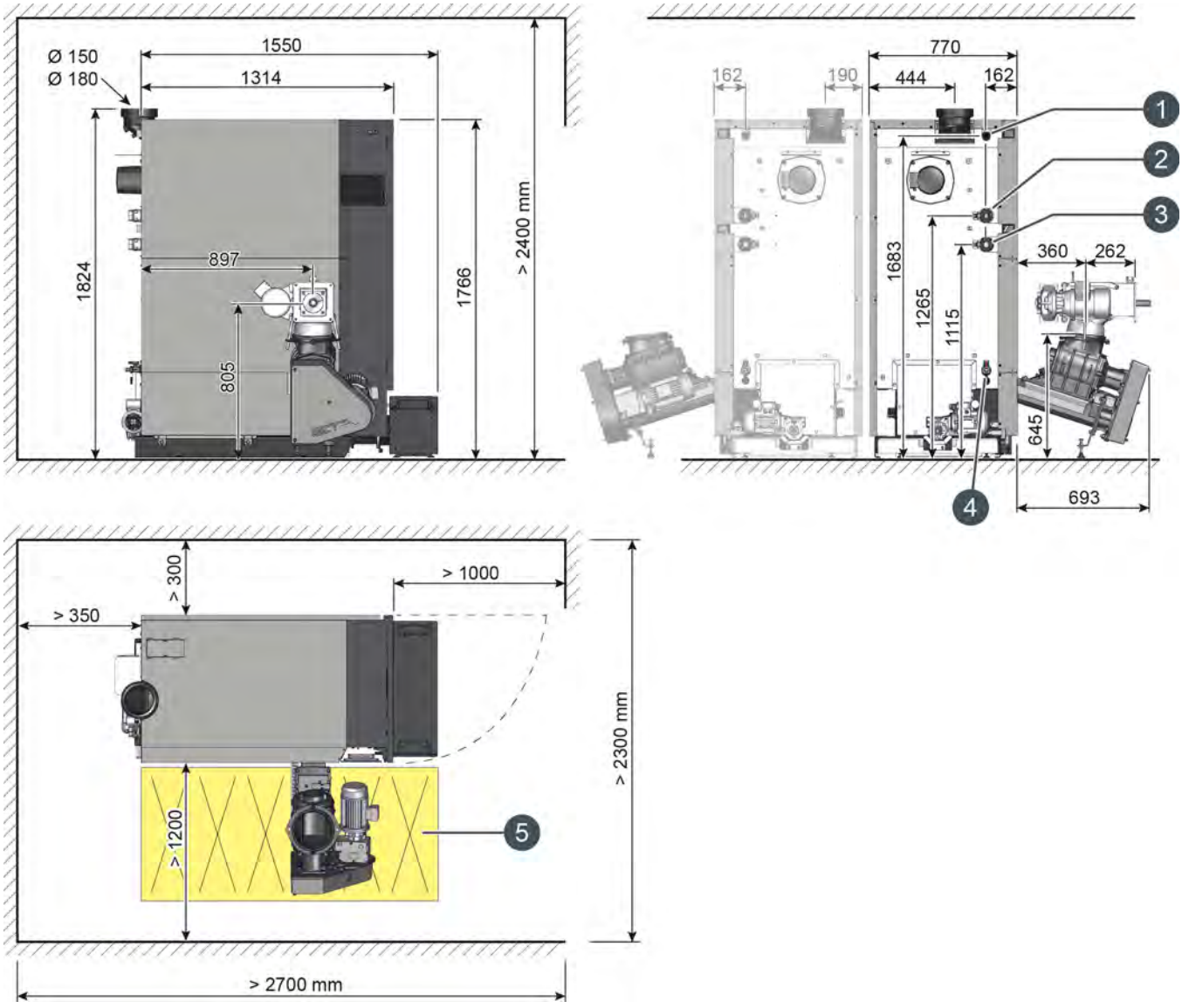
Wood chip boiler	Unit	20	25	32	45	50
Maximum permissible operating pressure	bar	3				
Temperature adjustment range	°C	70 – 85				
Maximum permissible operating temperature	°C	95				
Boiler class	5 acc. to EN 303-5:2012					
Suitable fuels	Wood chips ISO 17225-4, P16S-P31S (G30-G50), maximum 35% water content; pellets ISO 17225-2-A1, ENplus-A1					
Electrical connection	400 V AC / 50 Hz / 16 A / 3P+N+PE					
Mode of operation	non-condensing					

Subject to technical changes and errors

12.2 eHACK 60-80 kW

eHACK 60-80 kW wood chip boiler

The boiler can optionally be supplied with the stoker on either the right or the left side. The illustration shows a boiler with the stoker on the left side.



1 Connection for safety valve, pressure gauge and bleed valve R3/4" internal thread
2 Flow, R 6/4“
3 Return, R6/4“
4 Filling and draining valve
5 Maintenance area to be kept clear

For maintenance on the boiler, an area which is to be kept clear is required on the side of the boiler on which the conveying system (stoker) is mounted. The conveying system may not run through the maintenance area. Also, no expansion tanks or other devices may be installed in this area.

The flue gas connection on the boiler does not yet give any indication of the required chimney diameter. Information on the required chimney diameter can be found in the installation instructions for the boiler in the Chimney chapter.

Wood chip boiler	**Unit**	**60**	**70**	**80**
Rated capacity, wood chips M25 BD 150 (W25-S160)	kW	17.9 - 59.9	20.9 - 69.9	23.2 - 79.9
Rated capacity, pellets	kW	17.9 - 59.9	20.9 - 69.9	23.2 - 85
Efficiency with wood chips at partial / full load	%	94.1 / 94.7	94.9 / 94.6	95.7 / 94.6
Efficiency with pellets at partial / full load	%	93.4 / 93.5	93.3 / 93.3	93.3 / 93.1
Transport dimensions, W x D x H	mm	770 x 1455 x 1826		
Weight with / without rotary valve stoker	kg	1110 / 992		
Water content	litres	203		
Water-side pressure drop (ΔT = 20 K)	mWs	0.82	1.12	1.46
Available residual pump head (at ΔT = 20 K) for buffer operation	mws	4.5	3.7	2.5
	m³/h	2.6	3	3.4
Ash box volume	litres	52		
Flue gas mass flow rate, partial / full load	g/s	11.5 / 32.8	13.5 / 38.3	14.9 / 43.8
CO_2 content in dry exhaust gas partial/full load	%	11.4 / 14	11.4 / 13.9	11.5 / 13.9
Exhaust temperature at partial / full load	°C	~80 / ~150		
Required flue draught	Pa	> 5 Pa A draught limiter is required above 15 Pa		
Carbon monoxide (CO) emissions with wood chips at partial / full load	mg/MJ	24 / 9	19 / 7	13 / 4
	mg/m³ (13% O_2)	37 / 14	29 / 10	21 / 7
Carbon monoxide (CO) emissions with pellets at partial/full load	mg/MJ	19 / 5	18 / 4	17 / 3
	mg/m³ (13% O_2)	29 / 7	28 / 6	26 / 4
Dust emissions with wood chips at partial / full load	mg/MJ	4 / 6	5 / 6	5 / 7
	mg/m³ (13% O_2)	7 / 9	7 / 10	8 / 11
Dust emissions with pellets at partial / full load	mg/MJ	7 / 4	6 / 5	6 / 6
	mg/m³ (13% O_2)	10 / 6	9 / 7	9 / 9
Unburned hydrocarbon emissions (CxHy) with wood chips at partial / full load	mg/MJ	<1 / <1	<1 / <1	<1 / <1
	mg/m³ (13% O_2)	<1 / <1	<1 / <1	<1 / <1
Unburned hydrocarbons (CxHy) with pellets at partial/full load	mg/MJ	<1 / <1	<1 / <1	<1 / <1
	mg/m³ (13% O_2)	<1 / <1	<1 / <1	<1 / <1
Electrical power consumption with wood chips at partial / full load (=values with integrated precipitator)	W	63 / 145 (93 / 175)		
Electrical power consumption with pellets at partial / full load (=values with integrated precipitator)	W	59 / 140 (89 / 170)		
Electrical power consumption in ready mode	W	15		
Maximum permissible operating pressure	bar	3		
Temperature adjustment range	°C	70 – 85		

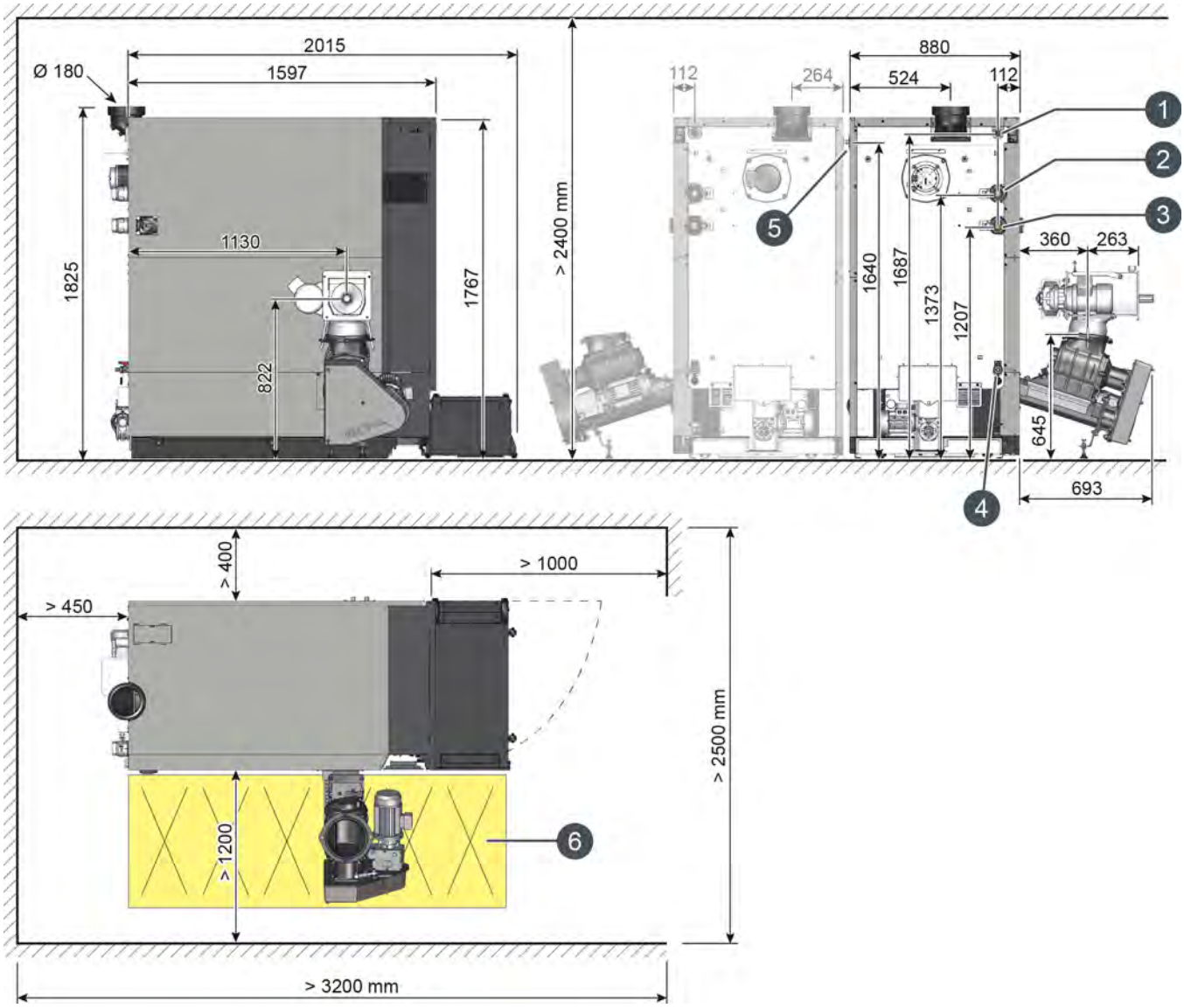
Wood chip boiler	Unit	60	70	80
Maximum permissible operating temperature	°C	95		
Boiler class	5 acc. to EN 303-5:2012			
Suitable fuels	Wood chips ISO 17225-4, P16S-P31S (G30-G50), maximum 35% water content; pellets ISO 17225-2-A1, ENplus-A1			
Electrical connection	400 V AC / 50 Hz / 16 A / 3P+N+PE			
Mode of operation	non-condensing			

Subject to technical changes and errors

12.3 eHACK 100-130 kW

eHACK 100-130 kW wood chip boiler

The boiler can optionally be supplied with the stoker on either the right or the left side. The illustration shows a boiler with the stoker on the left side.



1 Connection for safety valve, pressure gauge and bleed valve, R1“
2 Flow, R2“
3 Return, R2“
4 Filling and draining valve
5 Safety heat exchanger R1/2"
6 Maintenance area to be kept clear

For maintenance on the boiler, an area which is to be kept clear is required on the side of the boiler on which the conveying system (stoker) is mounted. The conveying system may not run through the maintenance area. Also, no expansion tanks or other devices may be installed in this area.

The flue gas connection on the boiler does not yet give any indication of the required chimney diameter. Information on the required chimney diameter can be found in the installation instructions for the boiler in the Chimney chapter.

Wood chip boiler	**Unit**	**100**	**110**	**120**	**130**
Rated capacity, wood chips M25 BD 150 (W25-S160)	kW	29.9 - 99.9	32.9 - 109.9	35.9 - 119.9	38.9 - 128.9
Rated capacity, pellets	kW	29.9 - 99.9	32.9 - 109.9	35.9 - 119.9	38.9 - 129.9
Efficiency with wood chips at partial / full load	%	95.1 / 93.8	94.8 / 93.4	94.6 / 93	94.6 / 93
Efficiency with pellets at partial/full load	%	92.8 / 93	92.4 / 93	92 / 92.9	92 / 92.9
Transport dimensions, W x D x H	mm	922 x 1764 x 1825			
Weight with / without rotary valve stoker	kg	1447 / 1329			
Water content	litres	272			
Water-side pressure drop (ΔT = 20 K)	mWs	0.778	0.941	1.121	1.331
Available residual pump head (at ΔT = 20 K) for buffer operation	mws	4.5	3.8	3.1	2.5
	m³/h	4.3	4.7	5.1	5.5
Ash box volume	litres	94			
Flue gas mass flow rate, partial / full load	g/s	18.1 / 54.5	20.3 / 61.7	22.4 / 68.9	24.6 / 76.1
CO_2 content in dry exhaust gas partial/full load	%	11.6 / 13.8	11.7 / 13.8	11.8 / 13.7	11.9 / 13.7
Exhaust temperature at partial / full load	°C	~70 / ~130			
Required flue draught	Pa	> 5 Pa A draught limiter is always required (≤15 Pa)			
Carbon monoxide (CO) emissions with wood chips at partial / full load	mg/MJ	24 / 3	29 / 3	35 / 3	35 / 3
	mg/m³ (13% O_2)	37 / 6	45 / 5	53 / 5	53 / 5
Carbon monoxide (CO) emissions with pellets at partial/full load	mg/MJ	19 / 2	20 / 2	21 / 2	21 / 2
	mg/m³ (13% O_2)	29 / 3	30 / 3	32 / 2	32 / 2
Dust emissions with wood chips at partial / full load	mg/MJ	7 / 9	8 / 9	8 / 10	8 / 10
	mg/m³ (13% O_2)	10 / 13	12 / 14	13 / 16	13 / 16
Dust emissions with pellets at partial / full load	mg/MJ	7 / 5	7 / 5	8 / 5	8 / 5
	mg/m³ (13% O_2)	10 / 8	11 / 8	12 / 7	12 / 7
Unburned hydrocarbon emissions (CxHy) with wood chips at partial/full load	mg/MJ	1 / <1	1 / <1	1 / <1	1 / <1
	mg/m³ (13% O_2)	<1 / <1	<1 / <1	<1 / <1	<1 / <1
Unburned hydrocarbons (CxHy) with pellets at partial/ full load	mg/MJ	<1 / <1	<1 / <1	<1 / <1	<1 / <1
	mg/m³ (13% O_2)	<1 / <1	<1 / <1	<1 / <1	<1 / <1
Electrical power consumption with wood chips at partial / full load (=values with integrated precipitator)	W	53 / 176 (152 / 263)			
Electrical power consumption with pellets at partial / full load (=values with integrated precipitator)	W	49 / 124 (148 / 211)			
Electrical power consumption in ready mode	W	13			
Maximum permissible operating pressure	bar	3			

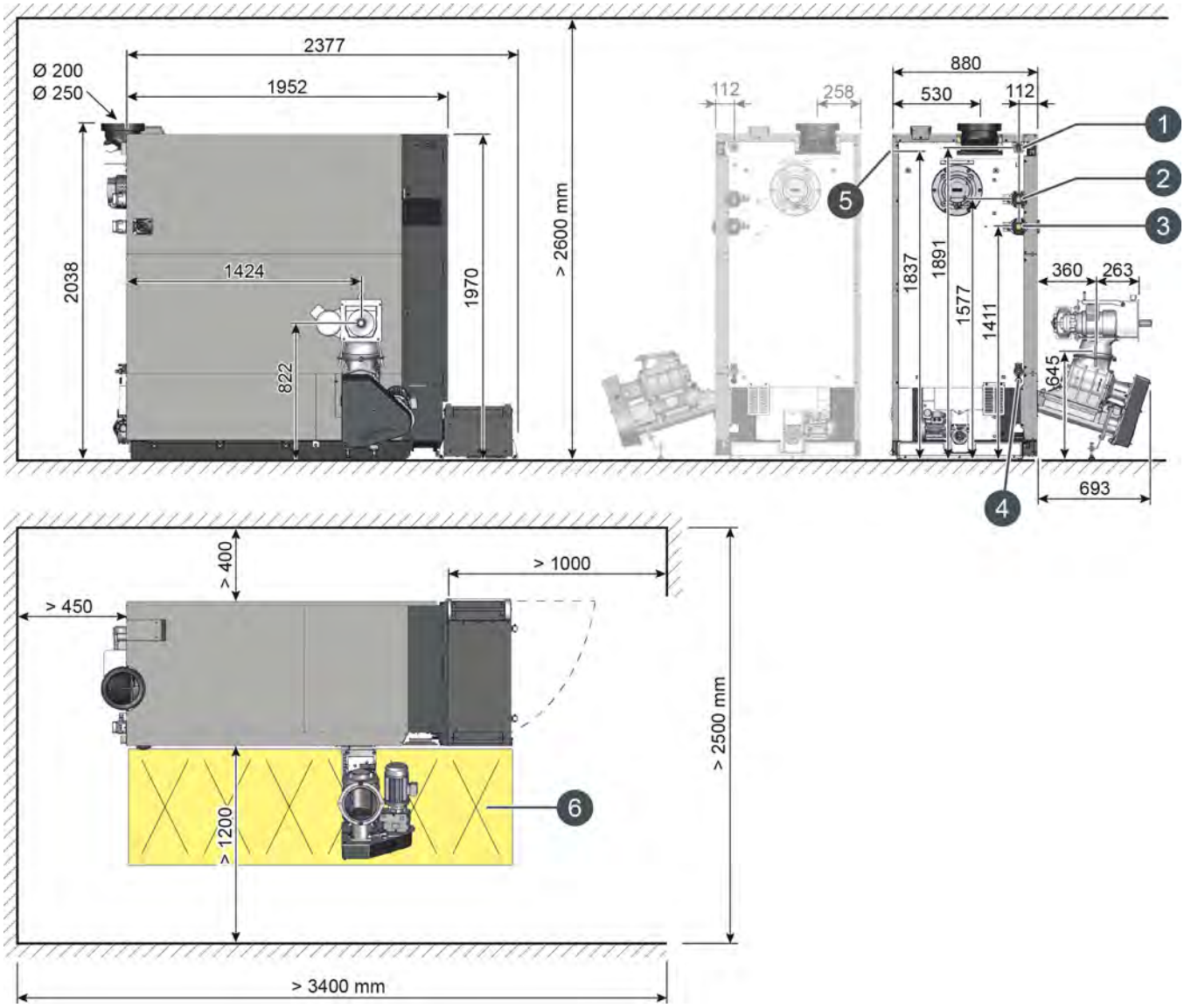
Wood chip boiler	Unit	100	110	120	130
Temperature adjustment range	°C	70 – 90			
Maximum permissible operating temperature	°C	95			
Boiler class	5 acc. to EN 303-5:2012				
Suitable fuels	Wood chips ISO 17225-4, P16S-P31S (G30-G50), maximum 35% water content; pellets ISO 17225-2-A1, ENplus-A1				
Electrical connection	400 V AC / 50 Hz / 16 A / 3P+N+PE				
Mode of operation	non-condensing				

Subject to technical changes and errors

12.4 eHACK 140-170 kW

eHACK 140-170 kW wood chip boiler

The boiler can optionally be supplied with the stoker on either the right or the left side. The illustration shows a boiler with the stoker on the left side.



1 Connection for safety valve, pressure gauge and bleed valve, R1“
2 Flow, R2“
3 Return, R2“
4 Filling and draining valve
5 Safety heat exchanger R1/2"
6 Maintenance area to be kept clear

For maintenance on the boiler, an area which is to be kept clear is required on the side of the boiler on which the conveying system (stoker) is mounted. The conveying system may not run through the maintenance area. Also, no expansion tanks or other devices may be installed in this area.

The flue gas connection on the boiler does not yet give any indication of the required chimney diameter. Information on the required chimney diameter can be found in the installation instructions for the boiler in the Chimney chapter.

Wood chip boiler	**Unit**	**140**	**150**	**160**	**170**
Rated capacity, wood chips M25 BD 150 (W25-S160)	kW	41.9 - 139.9	44.9 - 149.9	47.9 - 159.9	50.9 - 169.9
Rated capacity, pellets	kW	41.9 - 139.9	44.9 - 149.9	47.9 - 159.9	50.9 - 169.9
Efficiency with wood chips at partial/full load	%	95.1 / 93.5	95.3 / 93.8	95.6 / 94.1	95.9 / 94.4
Efficiency with pellets at partial/full load	%	92.8 / 93.4	93.1 / 93.6	93.5 / 93.9	93.9 / 94.1
Transport dimensions, W x D x H	mm	905 x 2073 x 1970			
Weight with / without rotary valve stoker	kg	1800 / 1682			
Water content	litres	347			
Water-side pressure drop (ΔT = 20 K)	mWs	0.66	0.76	0.87	0.98
Available residual pump head (at ΔT = 20 K) for buffer operation	mWs	8.9	6.6	5.5	5
	m³/h	6	6.4	6.8	7.2
Ash box volume	litres	94			
Flue gas mass flow rate, partial / full load	g/s	31 / 91	33 / 95	35 / 100	36 / 106
CO_2 content in dry exhaust gas partial/full load	%	12.1 / 14	12.2 / 14.2	12.2 / 14.4	12.3 / 14.6
Exhaust temperature at partial/full load	°C	~70 / ~130			
Required flue draught	Pa	> 5 Pa A draught limiter is always required (≤15 Pa)			
Carbon monoxide (CO) emissions with wood chips at partial / full load	mg/MJ	32 / 5	30 / 6	29 / 7	27 / 8
	mg/m³ (13% O_2)	49 / 8	46 / 9	44 / 11	42 / 13
Carbon monoxide (CO) emissions with pellets at partial/full load	mg/MJ	20 / 2	20 / 2	20 / 2	20 / 2
	mg/m³ (13% O_2)	31 / 3	31 / 3	30 / 3	30 / 3
Dust emissions with wood chips at partial/full load	mg/MJ	8 / 10	8 / 10	8 / 10	8 / 9
	mg/m³ (13% O_2)	13 / 15	13 / 15	13 / 15	13 / 14
Dust emissions with pellets at partial/full load	mg/MJ	8 / 5	8 / 5	8 / 5	8 / 6
	mg/m³ (13% O_2)	12 / 8	12 / 8	12 / 8	12 / 9
Unburned hydrocarbons (CxHy) with wood chips at partial/full load	mg/MJ	1 / 1	1 / 1	1 / 1	1 / 2
	mg/m³ (13% O_2)	1 / 1	1 / 1	1 / 2	1 / 2
Unburned hydrocarbons (CxHy) with pellets at partial/full load	mg/MJ	1 / <1	1 / <1	1 / <1	1 / <1
	mg/m³ (13% O_2)	1 / <1	1 / <1	1 / <1	1 / <1
Electrical power consumption with wood chips at partial/full load (=values with integrated precipitator)	W	80 / 201 (179 / 288)			
Electrical power consumption with pellets at partial/full load (=values with integrated precipitator)	W	76 / 149 (175 / 236)			
Electrical power consumption in ready mode	W	15			
Maximum permissible operating pressure	bar	3			

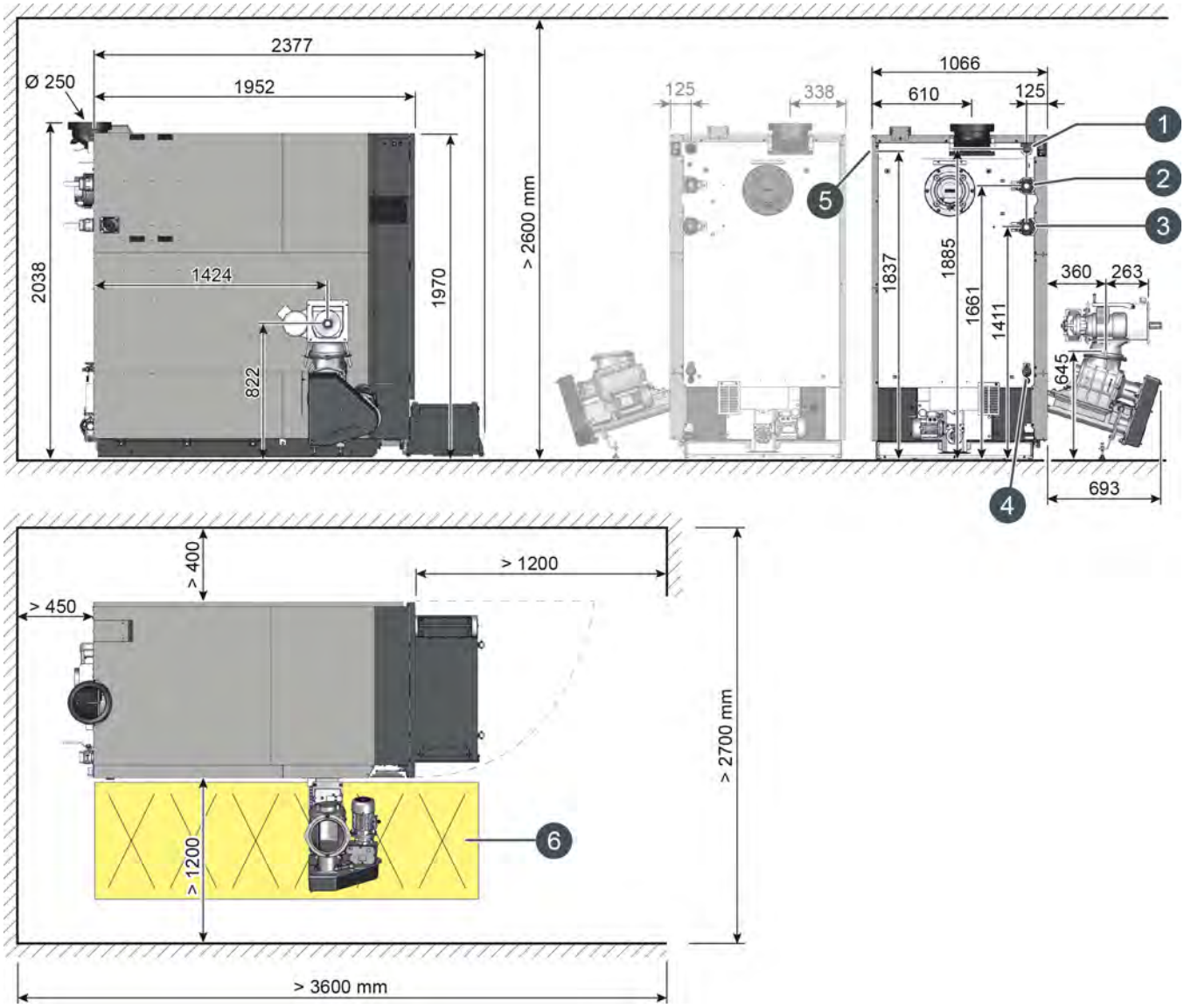
Wood chip boiler	Unit	140	150	160	170
Temperature adjustment range	°C	70 – 90			
Maximum permissible operating temperature	°C	95			
Boiler class	5 acc. to EN 303-5:2012				
Suitable fuels	Wood chips ISO 17225-4, P16S-P31S (G30-G50), maximum 35% water content; pellets ISO 17225-2-A1, ENplus-A1				
Electrical connection	400 V AC / 50 Hz / 16 A / 3P+N+PE				
Mode of operation	non-condensing				

Subject to technical changes and errors

12.5 eHACK 180 - 240 kW

Wood chip boiler eHACK 180-240 kW

The boiler can optionally be supplied with the stoker on either the right or the left side. The illustration shows a boiler with the stoker on the left side.



1 Connection for safety valve, pressure gauge and bleed valve, R5/4“
2 Flow, R2“
3 Return, R2“
4 Filling and draining valve
5 Safety heat exchanger R1/2"
6 Maintenance area to be kept clear

For maintenance on the boiler, an area which is to be kept clear is required on the side of the boiler on which the conveying system (stoker) is mounted. The conveying system may not run through the maintenance area. Also, no expansion tanks or other devices may be installed in this area.

The flue gas connection on the boiler does not yet give any indication of the required chimney diameter. Information on the required chimney diameter can be found in the installation instructions for the boiler in the Chimney chapter.

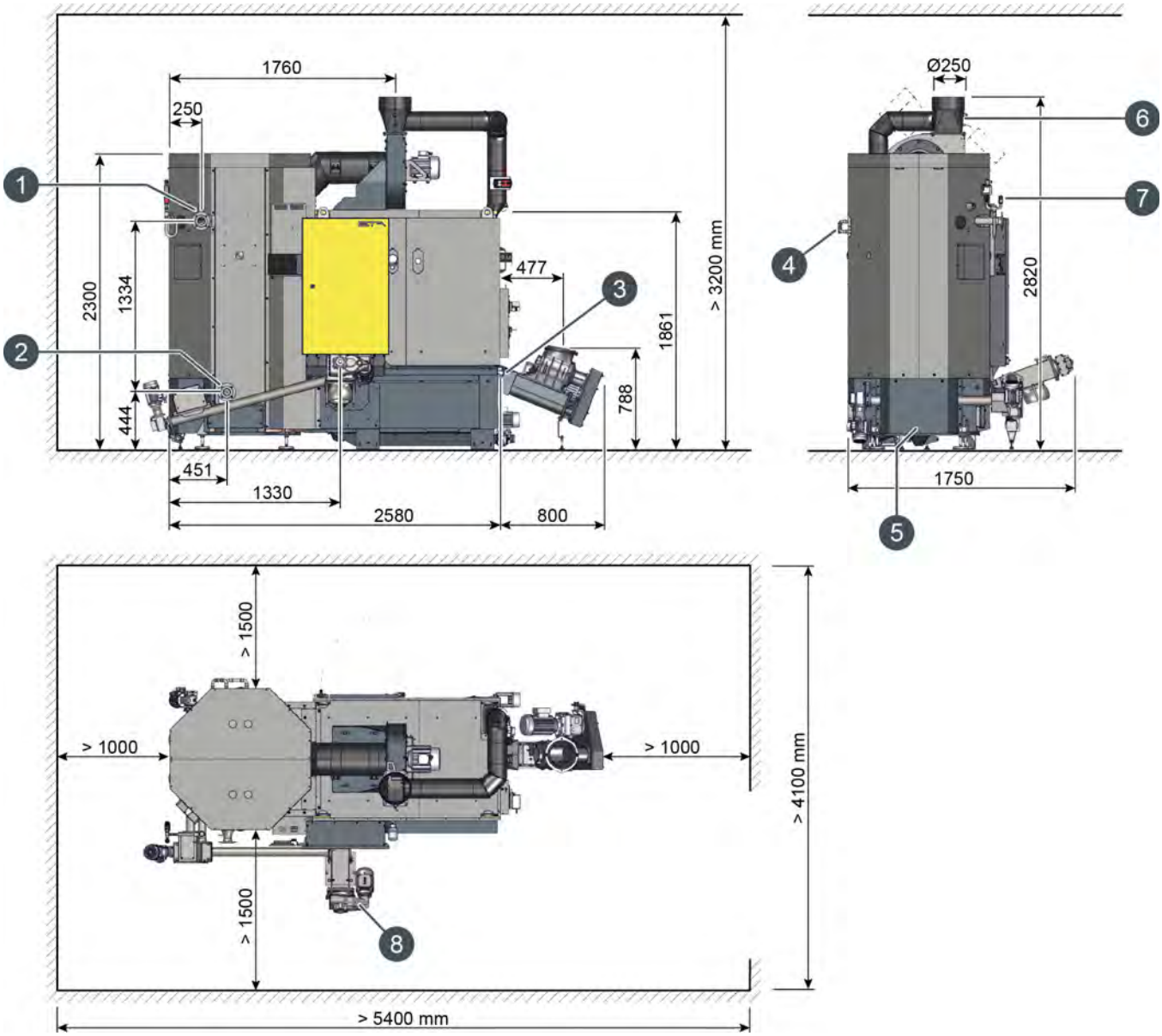
Wood chip boiler	**Unit**	**180**	**200**	**220**	**240**
Rated capacity, wood chips M25 BD 150 (W25-S160)	kW	53.9 - 179.9	59.9 - 199.9	65.9 - 219.9	71.4 - 238
Rated capacity, pellets	kW	53.9 - 179.9	59.9 - 199.9	65.9 - 219.9	71.9 - 239.9
Efficiency with wood chips at partial/full load	%	96.1 / 94.7	96.6 / 95.2	97.1 / 95.8	97.6 / 96.3
Efficiency with pellets at partial / full load	%	94.3 / 94.4	95 / 94.9	95.7 / 95.3	96.5 / 95.8
Transport dimensions, W x D x H	mm	1076 x 2073 x 1970			
Weight with / without rotary valve stoker	kg	2100 / 1982			
Water content	litres	434			
Water-side pressure drop (ΔT = 20 K)	mWs	0.83	1.03	1.24	1.46
Available residual pump head (at ΔT = 20 K) for buffer operation	mWs	6.5	5.5	4	2.5
	m³/h	7.7	8.5	9.4	10.2
Ash box volume	litres	94			
Flue gas mass flow rate, partial / full load	g/s	41 / 120	45 / 130	48 / 139	51 / 148
CO_2 content in dry exhaust gas partial/full load	%	11.1 / 13.2	11.2 / 13.4	11.2 / 13.7	11.3 / 13.9
Exhaust temperature at partial / full load	°C	~70 / ~130			
Required flue draught	Pa	> 5 Pa A draught limiter is always required (≤15 Pa)			
Carbon monoxide (CO) emissions with wood chips at partial / full load	mg/MJ	26 / 9	23 / 11	20 / 13	17 / 15
	mg/m³ (13% O_2)	40 / 14	35 / 17	31 / 21	27 / 23
Carbon monoxide (CO) emissions with pellets at partial/full load	mg/MJ	19 / 2	19 / 2	18 / 2	18 / 2
	mg/m³ (13% O_2)	29 / 3	29 / 3	28 / 3	27 / 3
Dust emissions with wood chips at partial/full load	mg/MJ	8 / 9	8 / 9	8 / 9	8 / 8
	mg/m³ (13% O_2)	13 / 14	13 / 14	13 / 13	13 / 13
Dust emissions with pellets at partial/full load	mg/MJ	8 / 6	7 / 6	7 / 6	7 / 7
	mg/m³ (13% O_2)	11 / 9	11 / 9	11 / 10	11 / 10
Unburned hydrocarbons (CxHy) with wood chips at partial/full load	mg/MJ	1 / 2	1 / 2	1 / 3	1 / 3
	mg/m³ (13% O_2)	1 / 2	1 / 3	1 / 4	1 / 4
Unburned hydrocarbons (CxHy) with pellets at partial/full load	mg/MJ	1 / <1	1 / <1	1 / <1	1 / <1
	mg/m³ (13% O_2)	1 / <1	1 / <1	1 / <1	1 / <1
Electrical power consumption with wood chips at partial/full load (=values with integrated precipitator)	W	126 / 473 (390 / 743)			
Electrical power consumption with pellets at partial / full load (=values with integrated precipitator)	W	78 / 227 (358 / 487)			
Electrical power consumption in ready mode	W	17			
Maximum permissible operating pressure	bar	3			

Wood chip boiler	Unit	180	200	220	240
Temperature adjustment range	°C	70 – 90			
Maximum permissible operating temperature	°C	95			
Boiler class	5 acc. to EN 303-5:2012				
Suitable fuels	Wood chips ISO 17225-4, P16S-P31S (G30-G50), maximum 35% water content; pellets ISO 17225-2-A1, ENplus-A1				
Electrical connection	400 V AC / 50 Hz / 16 A / 3P+N+PE				
Mode of operation	non-condensing				

Subject to technical changes and errors

12.6 HACK VR 250 kW

Data sheet for moving-grate boiler 250 kW



1 Flow with DN50 connecting flange
2 Return with DN50 connecting flange
3 Safety heat exchanger of the grate duct, connection R1/2“ inside thread
4 Safety heat exchanger for heat exchanger, connection R1/2“ inside thread
5 Discharge with coupling R1" (below cover)
6 Flue tube connector pivotable in 45° steps
7 Connection for safety valve R5/4“
8 De-ashing connection (left or right)

The flue gas connection on the boiler does not yet give any indication of the required chimney diameter. Information on the required chimney diameter can be found in the installation instructions for the boiler in the Chimney chapter.

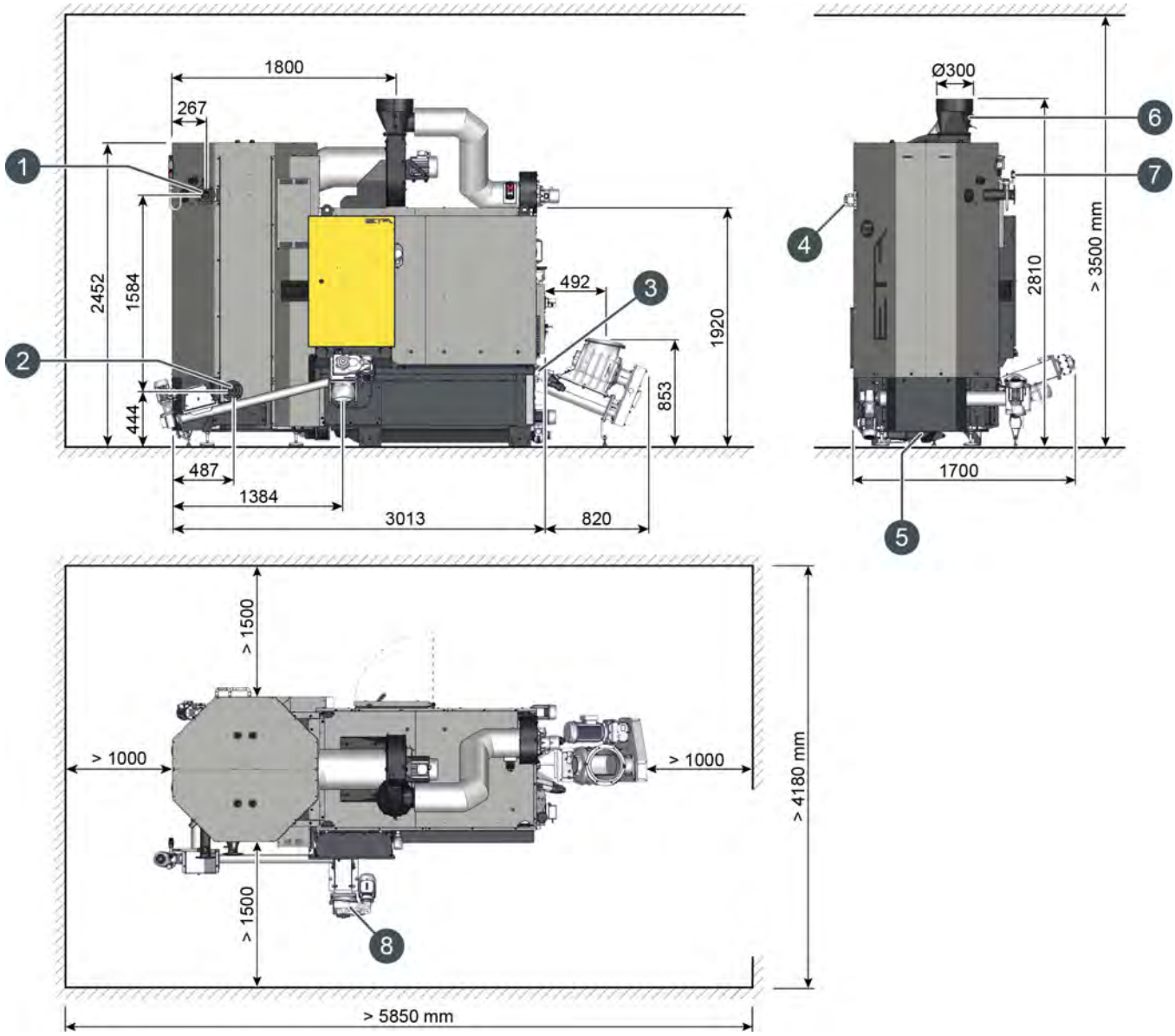
Moving-grate boiler	**Unit**	**250 kW**
Rated capacity, wood chips M25 BD 150 (W25-S160)	kW	74.9 - 249.9
Rated capacity of pellets	kW	74.9 - 249.9
Efficiency with spruce wood chips at partial/full load	%	92.6 / 92.8
Efficiency with pellets at partial/full load	%	92.4 / 92.7
Retort transport dimensions W x D x H	mm	1375 x 1685 x 1890
Heat exchanger transport dimensions W x D x H	mm	1240 x 1300 x 2210
Weight of the retort	kg	1850
Weight of heat exchanger	kg	1060
Weight of one-chamber rotary valve with stoker	kg	124
Total weight	kg	3144
Water content	litres	540
Water-side pressure drop (ΔT = 20K)	Pa / mWs	2400 / 0.24
Flue gas mass flow rate with spruce wood chips at full load	g / s	138
Flue gas mass flow rate with pellets at full load	g / s	140
CO_2 content in dry exhaust gas partial/full load	%	12.5 / 14.7
Exhaust temperature at partial / full load	°C	80 / 130
Required flue draught	Pa	> 5
Carbon monoxide (CO) emissions with wood chips at partial/full load	mg/MJ	8 / 1
	mg/m³ (13% O_2)	12 / 2
Dust emissions with wood chips at partial/full load	mg/MJ	7 / 7
	mg/m³ (13% O_2)	10 / 10
Unburned hydrocarbon emissions (CxHy) with wood chips at partial/full load	mg/MJ	1.3 / < 2
	mg/m³ (13% O_2)	2 /< 2
Carbon monoxide (CO) emissions with pellets at partial/full load	mg/MJ	21 / 4
	mg/m³ (13% O_2)	31 / 6
Dust emissions with pellets at partial/full load	mg/MJ	5 / 7
	mg/m³ (13% O_2)	8 / 10
Unburned hydrocarbons (CxHy) with pellets at partial/full load	mg/MJ	< 2 / < 2
	mg/m³ (13% O_2)	< 3 / < 2
Electrical power consumption in ready mode	W	19
Maximum permissible operating pressure	bar	6
Temperature adjustment range	°C	70 – 95
Maximum permissible operating temperature	°C	95
Minimum return temperature	°C	60°C for wood chips, 55°C for pellets
Boiler class	5 acc. to EN 303-5:2012	

Moving-grate boiler	Unit	250 kW
Suitable fuels	Wood chips ISO 17225-4, P16S-P31S (G30-G50), maximum water content 40%; Pellets ISO 17225-2-A1, ENplus-A1	
Electrical connection	400 V AC / 50 Hz / 16 A / 3P+N+PE	
Mode of operation	non-condensing	

Subject to technical changes and errors

12.7 HACK VR 333-350 kW

Data sheet for moving grate boiler 333- 350kW



1 Flow with DN65 connecting flange
2 Return with DN65 connecting flange
3 Safety heat exchanger of the grate duct, connection R1/2“ inside thread
4 Safety heat exchanger for heat exchanger, connection R1/2“ inside thread
5 Discharge with coupling R1" (below cover)
6 Flue tube connector pivotable in 45° steps
7 Connection for safety valve 6/4“ external thread
8 De-ashing connection (left or right)

The flue gas connection on the boiler does not yet give any indication of the required chimney diameter. Information on the required chimney diameter can be found in the installation instructions for the boiler in the Chimney chapter.

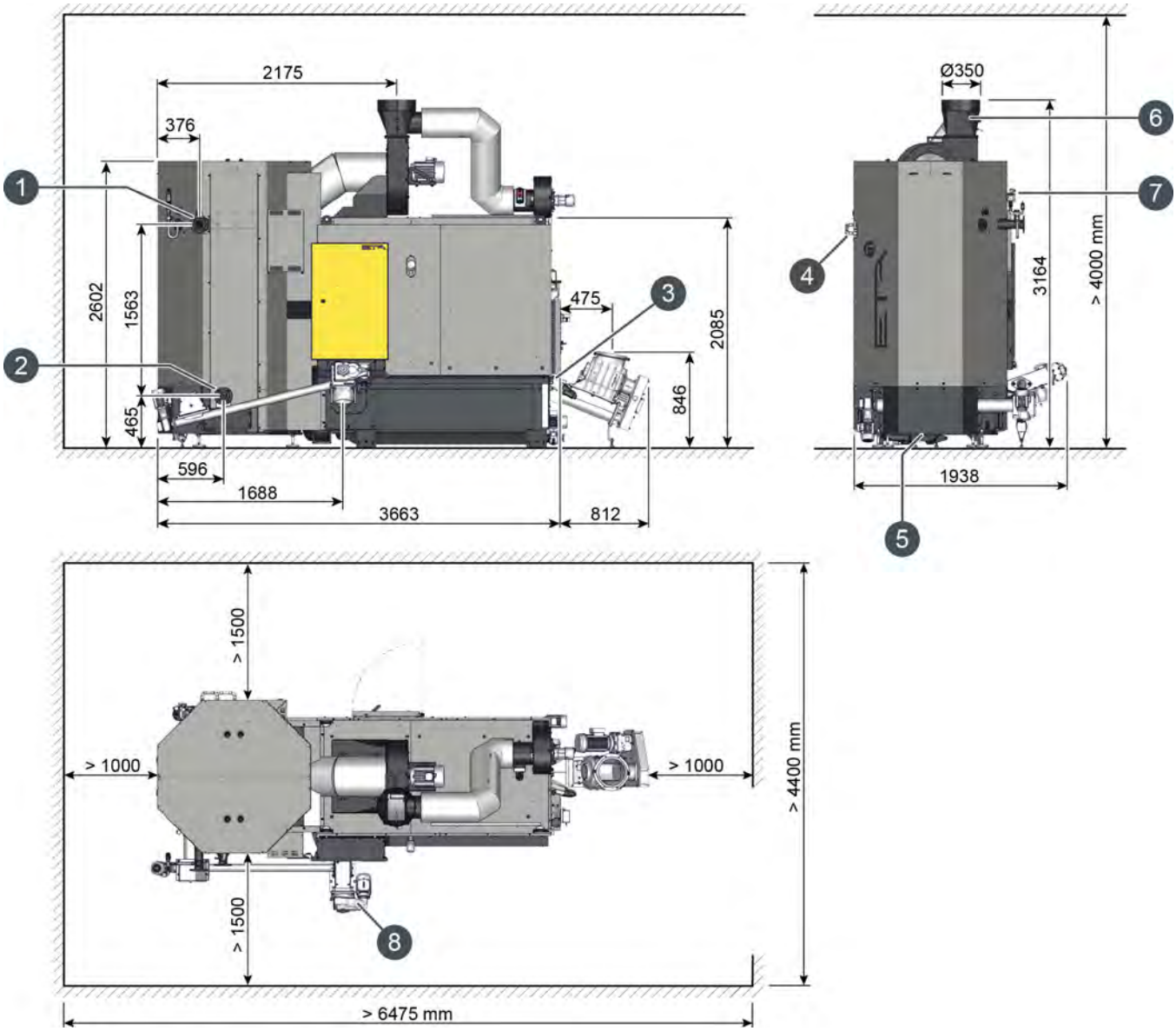
Moving-grate boiler	**Unit**	**333 kW**	**350 kW**
Rated capacity, wood chips M25 BD 150 (W25-S160)	kW	99 - 333	105 - 350
Rated capacity, pellets	kW	99 - 333	105 - 350
Efficiency with spruce wood chips at partial/full load	%	93.1 / 92.9	93.2 / 92.9
Efficiency with pellets at partial/full load	%	92.9 / 92.9	93.0 / 92.9
Retort transport dimensions W x D x H	mm	1300 x 2000 x 2000	
Heat exchanger transport dimensions W x D x H	mm	1300 x 2000 x 2500	
Weight of retort	kg	2505	
Weight of heat exchanger	kg	1454	
Weight of one-chamber rotary valve with stoker	kg	211	
Total weight	kg	4170	
Water content	litres	747	
Water-side resistance (ΔT = 20 °C)	Pa / mWs	9000 / 0.9	
Flue gas mass flow rate with spruce chips at partial/full load	g / s	52 / 190	52 / 201
Flue gas mass flow rate with pellets at partial/full load	g / s	48 / 173	48 / 184
CO_2 content in dry exhaust gas partial/full load	%	14.9 / 15.4	
Exhaust temperature at partial / full load	°C	~110 / ~200	
Required flue draught	Pa	>5	
Carbon monoxide (CO) emissions with wood chips at partial / full load	mg/MJ	9 / 1	9 / 1
	mg/m³ (13% O_2)	13 / 2	13 / 2
Dust emissions with wood chips at partial / full load	mg/MJ	5 / 7	5 / 7
	mg/m³ (13% O_2)	7 / 10	7 / 10
Unburned hydrocarbons (CxHy) with wood chips at partial/ full load	mg/MJ	<2 / <1	<2 / <1
	mg/m³ (13% O_2)	<2 / <2	<2 / <2
Carbon monoxide (CO) emissions with pellets at partial/full load	mg/MJ	18 / 5	17 / 5
	mg/m³ (13% O_2)	26 / 7	26 / 8
Dust emissions with pellets at partial/full load	mg/MJ	5 / 8	5 / 9
	mg/m³ (13% O_2)	8 / 12	7 / 13
Unburned hydrocarbons (CxHy) with pellets at partial/full load	mg/MJ	<1 / <1	<1 / <1
	mg/m³ (13% O_2)	<2 / <2	<2 / <2
Electrical power consumption in ready mode	W	10	
Maximum permissible operating pressure	bar	6	
Temperature adjustment range	°C	70 – 90	
Maximum permissible operating temperature	°C	95	
Minimum return temperature	°C	60	
Boiler class	5 acc. to EN 303-5:2012		

Moving-grate boiler	Unit	333 kW	350 kW
Suitable fuels	Wood chips ISO 17225-4, P16S-P31S (G30-G50), maximum water content 40%; Pellets ISO 17225-2-A1, ENplus-A1		
Electrical connection	400 V AC / 50 Hz / 16 A / 3P+N+PE		
Mode of operation	non-condensing		

Subject to technical changes and errors

12.8 HACK VR 463-500 kW

Data sheet moving grate boiler 463 - 500 kW



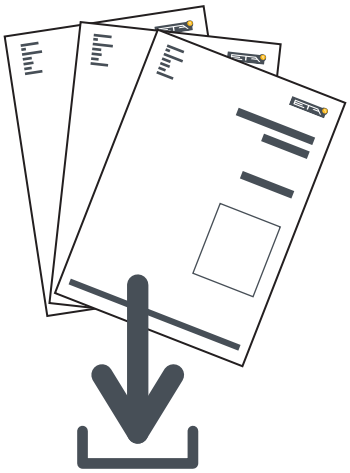
1 Flow with DN65 connecting flange
2 Return with DN65 connecting flange
3 Safety heat exchanger of the grate duct, connection R1/2“ inside thread
4 Safety heat exchanger for heat exchanger, connection R1/2“ inside thread
5 Discharge with coupling R1" (below cover)
6 Flue tube connector pivotable in 45° steps
7 Connection for safety valve 6/4“ external thread
8 De-ashing connection (left or right)

The flue gas connection on the boiler does not yet give any indication of the required chimney diameter. Information on the required chimney diameter can be found in the installation instructions for the boiler in the Chimney chapter.

Moving-grate boiler	Unit	463 kW	500 kW
Rated capacity, wood chips M25 BD 150 (W25-S160)	kW	126 - 463	135 - 499

Moving-grate boiler	**Unit**	**463 kW**	**500 kW**
Rated capacity, pellets	kW	126 - 463	135 - 499
Efficiency with spruce wood chips at partial/full load	%	93.8 / 93	94 / 93
Efficiency with pellets at partial/full load	%	93.6 / 93.1	93.8 / 93.2
Retort transport dimensions W x D x H	mm	1600 x 2300 x 2200	
Heat exchanger transport dimensions W x D x H	mm	1600 x 2300 x 2700	
Weight of retort	kg	3170	
Weight of heat exchanger	kg	1980	
Weight of one-chamber rotary valve with stoker	kg	221	
Total weight	kg	5371	
Water content	litres	1095	
Water-side resistance (ΔT = 20 °C)	Pa / mws	12 000 / 1.2	
Flue gas mass flow rate with spruce chips at partial / full load	g / s	84 / 278	84 / 302
Flue gas mass flow rate with pellets at partial/full load	g / s	75 / 255	75 / 274
CO_2 content in dry flue gas at partial / full load	%	14.4 / 14.5	
Exhaust temperature at partial / full load	°C	~110 / ~200	
Required flue draught	Pa	>5	
Carbon monoxide (CO) emissions with wood chips at partial / full load	mg/MJ	9 / 1	9 / 1
	mg/m³ (13% O_2)	13 / 2	13 / 2
Dust emissions with wood chips at partial / full load	mg/MJ	2 / 7	1 / 7
	mg/m³ (13% O_2)	3 / 10	2 / 10
Unburned hydrocarbon emissions (CxHy) with wood chips at partial / full load	mg/MJ	<1 / <1	<1 / <1
	mg/m³ (13% O_2)	<1 / <1	<1 / <1
Carbon monoxide (CO) emissions with pellets at partial/full load	mg/MJ	13 / 7	12 / 7
	mg/m³ (13% O_2)	20 / 10	18 / 10
Dust emissions with pellets at partial / full load	mg/MJ	4 / 10	4 / 10
	mg/m³ (13% O_2)	7 / 16	7 / 16
Unburned hydrocarbons (CxHy) with pellets at partial/full load	mg/MJ	<1 / <1	<1 / <1
	mg/m³ (13% O_2)	<1 / <1	<1 / <1
Electrical power consumption in ready mode	W	45	
Maximum permissible operating pressure	bar	6	
Temperature adjustment range	°C	70 – 90	
Maximum permissible operating temperature	°C	95	
Minimum return temperature	°C	60	
Boiler class	5 acc. to EN 303-5:2012		
Suitable fuels	Wood chips ISO 17225-4, P16S-P31S (G30-G50), maximum water content 40%; Pellets ISO 17225-2-A1, ENplus-A1		
Electrical connection	400 V AC / 50 Hz / 16 A / 3P+N+PE		
Mode of operation	non-condensing		

Subject to technical changes and errors



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