Stainless steel chimneys

Summary: Why stainless steel for chimneys?

Stainless steel upgrades chimneys into architectural features. Photo: Poujoulat, Saint Symphorien (F)

Stainless steel solutions for chimneys are a preferred option for renovation because:

- they can often be installed by lowering the liners from the chimney top to the heating installation without the need to open walls inside the building;
- they are easy to retrofit, even in the case of complex building geometries.

Also, in new building, stainless steel chimneys:

- are a space-saving option;
- can be used as an architectural feature;
- have proven particularly cost-effective because of their easy and rapid installation;
- are easy to service and, if necessary, repair or replace (fully or partially).

Stainless steel chimneys are environmentally friendly because:

- their chemical resistance makes them suitable for condensing boilers, which involve the formation of aggressive condensates;
- their thin walls make them a material-saving option;
- at the end of the useful life of the building, they are fully recyclable and even have a positive material value.

Valuable safety features include:

- good resistance to soot fires – after inspection, stainless steel chimneys often go back to normal use after an incident;
- outstanding shock resistance – the chimney will not tend to break or crack following settlements in the building or even seismic movements.

Requirements

Chimneys are an integral part of a building, even more so as the discharge of flue gases from the heating system to the outside is safety-critical. The following characteristics are important for chimney systems [1]:

Stainless steel flues are resistant to the acidic conditions created by condensing boilers. Photo: Poujoulat, Saint Symphorien (F)

Acid resistance
Pollutants in the flue gas either come from the combustible or form during the combustion process. Together with moisture, they may develop aggressive acids that condensate on the chimney wall, attacking the material.

Moisture resistance
If the flue gas temperature drops below dew point – which is automatically the case in, for example, condensing boilers – condensate will form on the chimney walls. Moisture resistant materials contain the condensate within the system and prevent humidity penetrating the surrounding materials.

Soot-fire resistance
When solid fuels such as wood are used, soot particles may deposit on the wall of the chimney. If the chimney is not cleaned regularly and completely, these particles can catch fire and cause soot fire. Soot-fire-resistant materials endure high temperatures of over 1000°C and limit heat transfer to the structure of the building to acceptable levels.

Stainless steels fulfil all these requirements.

Types of building application

Double-walled, thermally insulated external chimneys were originally conceived for renovation. Photo: Roccheggiani, Camerano, Ancona (I)

Renovation and retrofitting
Stainless steel chimneys[1] are best known for their use in the refurbishment or replacement of obsolete and defective chimneys. Rigid and flexible liners provide minimally invasive options, requiring no masonry work. Typical renovation solutions do not interfere with the normal use of a building and can thus avoid unnecessary nuisance to inhabitants. They are also useful for listed buildings, where the impact of the renewal has to be minimised.

Stainless steel chimneys are also preferred when cassettes or stoves are retrofitted – as an alternative source of heat or as an interior

[1] *The terms "flue" and "chimney" are often used interchangeably. The flue is the working part of the chimney, conveying the products of combustion safely to the atmosphere. The chimney includes the shaft within which the flue is housed. A flue works under negative pressure, drawing the product of combustion from the appliance [2].*

Increasingly, external stainless steel chimneys are used for architectural reasons.
Photo: Poujoulat, Saint Symphorien (F)

design feature. If the existing chimney does not permit the installation of a stove, the latter can be placed near external walls, so the chimney penetrates the wall and is fastened to the outside of the building.

However, the potential of stainless steel solutions goes beyond renovation and retrofitting. There are also good functional and architectural reasons to use them in newly erected buildings.

Newly built houses
Thermally insulated, double-walled chimneys can be attached to a façade. No space is needed inside the building. This gives the architect greater freedom in the ground plan. Bright, shiny stainless steel contrasts nicely with brick, plaster, natural stone, wood or other façade materials.

Apartment buildings
In apartment buildings, stainless steel chimneys are a useful way to lend structure to uniform facades.

Public buildings
Technical installations can be upgraded into architectural features. Hospitals, public swimming pools and other buildings with a regular need for thermal energy are increasingly being extended into cogeneration plants, for the combined production of electricity and heat. Other installations also work as district heating. The economy of scale is considerable. Retrofitting a high-performance cogeneration plant, however, requires installing larger chimneys. Stainless steel chimneys can add to the buildings' attractiveness and make them landmarks in the urban environment.

Chimneys can make a contribution to the architectural quality of public buildings.
Photo: Dinak, Vigo (E)

Industrial structures and energy production
In industrial structures, economic considerations are the primary factors affecting choice. Here, too, stainless steel is an option. Stainless steel has high intrinsic corrosion resistance, which does not depend on applied metallic or organic surface layers. It creates optimal conditions for long-term trouble-free service – even in demanding, industrial atmospheric conditions.

Types of chimneys

Interior architects use stainless steel connecting flue pipes to provide a touch of minimalist elegance. Photo: Poujoulat, Saint-Symphorien (F)

Double-walled design and thermal insulation ensure that external chimneys (above) provide as much draught as classic internal chimneys (below). Photos: Poujoulat, Saint-Symphorien (F)

European Standard EN 1443:2003 Chimneys – General Requirements categorises chimneys and flues into three basic types:

- **Custom Built Chimneys** – constructed on site, using factory-made flue liners.
- **System Chimneys** – prefabricated chimney systems, manufactured in a factory and assembled on site. The key benefits of chimney systems lie in their off-site production and preformed insulation.
- **Connecting Flue Pipes** – pipe specifically designed to connect an appliance to the flue or chimney.

Chimneys and flues are available in a number of different materials – stainless steel, concrete, pumice, clay or ceramic and plastic. Concrete, pumice and clay or ceramic are collectively referred to as masonry chimneys. Plastic flues are only allowed to be used with low-temperature condensing applications [2].

Stainless steel system chimneys consist of two concentric stainless steel metal walls with insulating material filling the annular space in between. They are a preferred option for existing buildings, since they do not require a dedicated foundation and can easily be retrofitted [2].

External chimneys

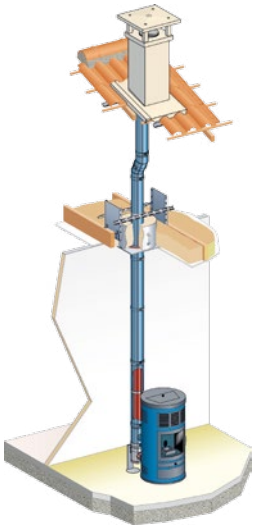
Chimneys situated outside a building can be affected by cold weather, which can lead to poor up-draught and condensation. It is therefore essential to keep the flue-gas temperature at a sufficient level all the way to the top of the chimney. Insulation is among the key performance characteristics of a chimney and should be applied along the full length of the flue. Industrial manufacturing ensures that a highly efficient insulation is applied, with a consistent level of quality.

Internal chimneys

The classic position of a chimney is on the inside of the building, because this minimises temperature loss [3]. One of the most common solutions is an internal, twin-walled insulated flue system that goes straight up from the boiler, through the floors and ceilings and finally the roof. An internal flue system keeps the flue gases hot, which enhances draw and reduces deposits. In new building, this is usually cost-effective and easy to install and avoids bends and tee pieces [4].

New installation

In twin-walled chimneys, different stainless steel grades may be used for the inner wall, which comes into contact with the flue gas, and the external wall, which has to withstand atmospheric conditions only. Photo: Schiedel, Vienna (A).



Triple-walled chimneys, designed for modern airtight buildings, have another annular chamber through which the combustion air is sucked in. Photo: Poujoulat, Saint Symphorien (F)

Single-walled

Single-walled systems are only found in connecting flue pipes. Stainless steel versions have an additional decorative function.

Twin-walled

By using a twin-walled insulated flue system, a stove can be installed practically anywhere, even if there is no pre-existing chimney. A twin-walled insulated flue with welded seams and an inner layer made of 1.4404 (316L) grade stainless steel – some countries also accept grade 1.4301/304 – is able to withstand corrosive flue gases produced by wood burning and multi-fuel stoves. It can be used internally or externally, since the outer layer is also made of stainless steel. The insulation between the stainless steel layers keeps the outside of the flue cold, while the flue gases remain hot enough for proper draught. This prevents unacceptable levels of tar deposits, which could cause chimney fires [11]. Double-skin insulated flue pipes can safely pass through existing floors and the roof [12].

Triple-walled

Triple-walled chimneys have an air channel between the flue and the outer wall. [13]. The outer wall of the chimney pipe can be either stainless steel or galvanized steel. The inner wall is always made of stainless steel. This design is increasingly used for airtight houses – as required by European and national energy-saving standards.

Relining existing chimneys

Rigid liners reduce the diameter of pre-existing chimneys, optimising draught and preventing unwanted condensation. Photo: Schiedel, Vienna (A)

There can be several reasons for lining an old chimney [3, 7, 8]:

- There is a change of the chimney use, such as the installation of a smaller, more efficient appliance or an insert into an existing fireplace.
- The flue leaks smoke and fumes into the building.
- Condensates or tar seep through the chimney walls, causing staining either inside or outside the building (a common problem with wood-burning stoves).
- The flue becomes too large for the type of fire or appliance used, for instance when a heating system is converted from solid fuel to oil or gas.
- The flue is too cold, particularly if on an outside wall, and is not drawing properly.
- The old flue surface is eroded and rough, causing frictional resistance to the flow of the gases and, consequently, poor draught.

With the installation of a new liner, the performance and safety of a chimney is improved. Stainless steel liners are a proven solution that is easy to implement. There are two different options for lining the chimney with metal liners [7]:

- Solid-fuel liners are double-skinned and made from a higher-alloyed stainless steel. Featuring a smooth inner and a corrugated outer surface, they are specifically designed for relining flues for solid fuel and wood. Typically, the air space between the liner and the old chimney walls serves as insulation. It is essential to follow the manufacturer's instruction for installation carefully.
- Gas and oil flue liners are light-gauge single-skin models. only suitable for closed gas fires and boilers. They are usually made from stainless steel grade 1.4301/1.4307 (304/304L) or 1.4401/1.4404 (316/316L). Wall thickness varies from one country to another and can be from 0.4 mm to 1 mm.

It should be borne in mind that relining of any type is a repair solution and does not strengthen an unstable chimney. If a chimney is mechanically weak, it should be examined by a structural engineer or builder and undergo appropriate repair before relining [9].

Single-walled pipes are used for renovation. Photo: Dinak, Vigo (E)

Flexible liners are a preferred refurbishment solution because they are quick and cost-effective to install. Photo: Poujoulat, Saint-Symphorien (F)

When refurbishing existing chimneys, there are two options: rigid and flexible liners.

Rigid liners

Rigid stainless steel liners are used for appliances that burn wood, pellets, gas and oil. When heating installations are converted from solid fuel to oil and gas, the chimneys must usually be reduced in diameter. Stainless steel rigid liners are a popular, efficient and economical way to refurbish existing chimneys. Many existing chimneys are made from bricks. Over time, these can break or crack, making the chimney unsafe. Gas-tight stainless steel inserts are a rapid, economical repair solution, involving minimal intrusion into the existing building [5].

Flexible liners

Flexible liners are used for the refurbishment of existing chimneys with complex geometries. Stainless steel flexible liners are designed to adapt to the shape of the chimney. They are factory-made from two overlapping strips of stainless steel, to ensure a smooth, sealed flue-way. The liners are installed by either lowering them into the chimney from the rooftop or pulling them up from the bottom. They can follow the curvature of most bends. Their slim profile makes it possible to insert them even into chimneys that would be too small in diameter for other materials. However, their service life can be reduced if abnormally corrosive soot or condensate is allowed to deposit or if such accumulations are not thoroughly removed from the walls of the existing flue before renovation [6]. Most national regulations stipulate that there can be a maximum of one offset. The maximum angle is 45° (in some countries 30°) [2]. Stainless steel flexible liners are certified to EN 1856-2.

Care must be taken when selecting flexible liners, which are available in two types:

- single skin liners, for use with gas appliances;
- twin skin liners, which should be used with wood and multi-fuel appliances.

Single skin liners must never be used with wood or multi-fuel applications [6].

Fuels

Stainless steel chimneys contribute to the clean burning of modern fuels – including pellets, which are growing in importance as renewable sources of energy. Photo: Poujoulat, Saint-Symphorien (F)

Selecting the right type and size of fuel is essential for the satisfactory operation of a heating appliance. Some appliances burn a wide range of fuels, but some are designed for a specific type, such as wood pellets or chips, and will only work reliably and safely with the appropriate type of fuel [14]. Stainless steel is suitable for all usual room-heating fuels:

- **Natural gas and liquid gas** produce the flue gas that is the least corrosive to chimney materials.
- **Oil** contains sulphur but the sulphur content of normal heating oil for domestic applications is uncritical for molybdenum-alloyed stainless steels.
- **Wooden fuels**[3] in the form of logs, chips and pellets involve particles, which may accumulate if the chimney is not cleaned properly. Experience has shown, however, that stainless steel chimneys can survive chimney fires.
- **Lignite** (brown coal) briquettes and hard coal are predominantly used in parts of Europe where these types of fuel are locally available. As natural products, they are variable in composition. The design of the installation should ensure that the flue-gas temperature remains high enough to produce proper draught. Excessive loss of temperature could lead to condensation.

Most reported cases of damage to chimneys or flue liners were attributable to the burning of household waste, plastics or chemicals, which produce harmful fumes and corrosive vapours. These can be dangerous to health and cause premature corrosion in metals [3].

[3] *Experience with alternative bio-fuels such as miscanthus is still limited. Fast-growing wood tends to be quite corrosive, especially in condensing conditions. Material recommendations are a matter of expert discussion and ongoing research.*

Compatibility with other materials

Only stainless steel fasteners should be used to attach stainless steel chimneys to a building. Galvanised steel, if in contact with stainless steel, may suffer galvanic corrosion.

When stainless steel chimneys penetrate metallic roofs, the galvanic compatibility of the partner materials must be given special attention. Photo: W. De Roover, Ghent (B)

The installation of combustion appliances, chimneys and associated systems is usually covered by regulations. In mixed-metal designs, care should be taken to avoid galvanic corrosion[1]. This type of corrosion occurs when two metals of different electrochemical potentials – one "noble" (such as stainless steel) and the other one less "noble" (for instance, zinc) – come into direct contact with one another and an electrolyte (such as rainwater) is present. In this case a current flows, as in a battery, and the less-noble partner metal is consumed, suffering accelerated corrosion.

Fasteners

Only stainless steel fasteners should be used for joining stainless steel parts. Any direct contact between stainless steel and galvanised elements should be avoided, since the latter will soon start to corrode – usually within less than a year of installation.

Metallic roofing materials

When stainless steel chimneys penetrate the roof, they can be in contact with other metallic materials. Some simple rules should be followed to avoid galvanic corrosion:

- No problems are to be expected when stainless steel is combined with copper, as both these materials have similar electrochemical potentials.
- Components made of hot-dip galvanized steel can be combined with stainless steel if they are much larger in surface than the stainless steel part.
- The combination of zinc roofs and stainless steel chimneys involves a risk of galvanic corrosion. However, chimney manufacturers provide insulating collars. These eliminate one prerequisite for galvanic corrosion – electrically conductive contact between the metals – and thus avoid potential problems.

[1] *Arlt, N., Burkert, A. Isecke, B., Stainless Steel in Contact with Other Metallic Materials, Euro Inox, 2009, Materials and Applications Series, Volume 10, http://www.euro-inox.org/pdf/map/Contact_with_Other_EN.pdf*

Chimney manufacturers provide insulation sleeves for roof penetrations, which eliminate fire risks. Photo: Schiedel, Vienna (A)

Wooden roof structures

When wooden roof structures are penetrated by chimneys, fire risk has to be taken into account. Only insulated chimneys should be used for this purpose. The minimum distance from combustible materials must be tested by the manufacturer. Usually, this is in the 50 to 100 mm range. Special manufacturer-tested insulation sleeves are available.

Accessories

Stainless steel chimneys are often combined with ventilation equipment made from the same material.

There are many types of chimney post and terminal, in different styles and shapes, to suit almost any taste and application. Different solutions are available from chimney manufacturers. In addition to visual appearance, accessories also provide technical functions.

Stainless steel terminals are usually fitted for one of two reasons:

- **Weather, bird and debris protection.** A properly designed terminal will not negatively affect the draught of the chimney.
- **Resolution of downdraught problems.** A stainless steel anti-down-draught terminal can enhance airflow and chimney performance. These are also designed to provide weather, bird and debris protection.

Stainless steel terminals can be fitted to any type of flue and chimney installation and material, including clay/ceramic, concrete and pumice. They can be supplied either as part of the chimney system or are available separately from reputable chimney-terminal manufacturers [2].

CE designations for stainless steel flues

Chimneys are subject to harmonized European standards.

Stainless steel chimneys are subject to two European standards:

- EN 1856-1 Chimneys – Requirements for metal chimneys – Part 1: System chimney products
- EN 1856-2 Chimneys – Requirements for metal chimneys – Part 2: Metal flue liners and connecting flue pipes

One of the key features of EN 1856-1 is a user-readable classification system that designates the features of the product. A label showing the classification is mandatory with each flue component. Understanding the classification can make the job of selecting the right flue much easier and will allow you to compare different flues. It is easy to use and the diagram below unlocks the coded information [2].

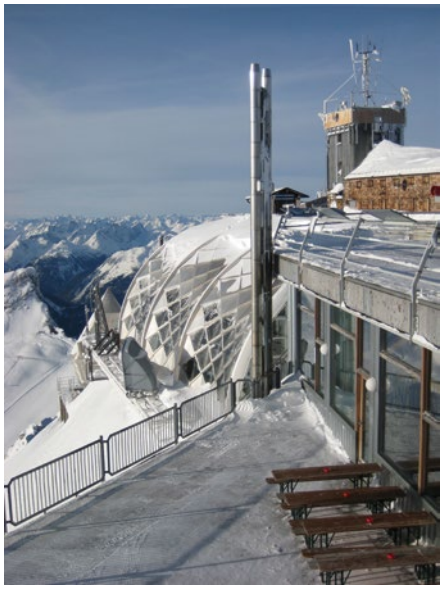
1	2	3	4	5	6	7	8	9	10
Metal Chimney System	**EN 1856-1**	**T450**	**N1**	**W**	**V2**	**L50**	**050**	**G**	**75**

1. Product Description
2. Standard Number
3. Temperature Rating
4. Pressure Rating (N = Negative, P = Pressure, H = High Pressure)
5. Condensate Resistance (W = Wet, D = Dry)
6. Corrosion Resistance
7. Liner Material
8. Material Thickness
9. Soot Fire Resistance (G = Yes, O = No)
10. Distance to combustibles

Picking out a few of the main points:

Temperature Rating – Maximum temperature (°C) for continuous use of the flue. T450 is suitable for multi-fuel. T200 is suitable for gas and oil.

Corrosion Resistance – This is fuel-dependent and goes from **V1** (suitable for gas) to **V3** (to withstand, among other things, combustion gases from heavy oil with a sulphur content › 0.2%) in dry conditions. **Vm** = not tested but declared by the manufacturer.



Stainless steel chimneys are a symbol of efficient and clean heating.

Liner Material and Thickness – Stainless steel grades are designated by code, where, for example, L50 stands for steel grade 1.4404 (316L) and L20 for steel grade 1.4301 (304). In conditions with higher corrosion load (wet), created by high-efficiency condensing boilers, stainless steel grade 1.4404 (316L) is mostly required. Other designations are L30 for 1.4307 (304L), L40 for 1.4401 (316), L60 for 1.4432 and L70 for 1.4539 (904L). Thickness is indicated in multiples of the unit 0.01 mm.

Soot Fire Resistance and Distance to Combustibles – Expressed as either G, for "soot-fire resistant" or O for "not soot-fire resistant", followed by the declared minimum distance to flammable materials expressed in mm. The G classification means that the product has been tested at 1000°C for 30 minutes and remains intact. The temperature of combustible material at the designed distance must not exceed 100°C at an ambient temperature of 20°C.

Distance to Combustibles for Connecting Flue Pipe – For connection flue pipes, the distance to combustible materials can me measured during the thermal test and declared accordingly (M). As an alternative, it can be declared to be three times the pipe diameter without measuring (NM). Manufacturers may provide shielding solutions that make it possible to reduce the minimum distance.

Stainless steel chimneys available on the European market are CE marked. The CE mark – compulsory since April 2005 – is the symbol certifying that the product conforms to standards EN 1856-1 and -2. This standard specifies the performance requirements for rigid single- and multi-walled system chimney products with metallic liners (chimney sections, chimney fittings and terminals, including supports) used to convey the products of combustion from appliances to the outside atmosphere. Standard EN 1856-1 does not apply to self-standing chimneys. The CE mark enables the product to circulate freely in the European market, but each country may have its own installation rules [15].

References

[1] European Chimney Association, Technology, available at http://www.eca-europe.org/index.php?site=technologie&pwd=, ‹Accessed on 17 September 2013›

Their combined corrosion and high temperature resistance makes stainless steel an optimal choice for lightweight, elegant chimneys. Photo: Roccheggiani, Camerano, Ancona (I)

[2] General Guidance on the selection and installation of flues and chimneys for wood burning and multi fuel appliances in residential properties, BFCMA, www.bfcma.co.uk

[3] A guide to choosing and using flues and chimneys for domestic solid fuel and wood burning appliances, BFCMA, 2007, available at http://www.lowimpact.org/books/flues_chimneys.pdf, ‹Accessed on 3 October 2013›

[4] Flue and Chimney Design Service – Internal insulated flue, available at http://www.stovesonline.co.uk/internal-insulated-flue-system.html, ‹Accessed on 3 October 2013›

[5] Stainless Steel Chimney Liners: Frequently Asked Questions, available at http://www.rockfordchimneysupply.com/FAQ.php#chimney-relining-system, ‹Accessed on 3 October 2013›

[6] Types of Chimneys and Flue Systems, available at http://www.bfcma.co.uk/chimneys-and-flue.aspx, ‹Accessed on 10 September 2013›

[7] Lining old chimneys, Solid Fuel Association, available at http://www.solidfuel.co.uk/pdfs/lining_old_chimneys.pdf, ‹Accessed on 10 September 2013›

[8] Gulland J., Best practices for chimney liner installation, Hearth & Home, October 2005, p. 68-76

[9] A Guide to choosing and using flues and chimneys for domestic gas burning appliances, BFCMA, 2007, available at http://specflue.com/resources/content/file/regulations/bfcma-guide-gas.pdf, ‹Accessed on 17 September 2013›

[10] Single skin flue, available at http://www.stovesonline.co.uk/wood_burning_stoves/Single-skin-flue.html, ‹Accessed on 10 September 2013›

[11] Double skin insulated flue, available at http://www.stovesonline.co.uk/wood_burning_stoves/Double-skin-insulated-flue.html, ‹Accessed on 10 September 2013›

[12] Insulated Flue Pipe Installation - Build a new Chimney, available at http://www.stovesonline.co.uk/make_a_chimney.html

[13] Chimney Troubleshooting Guide, ICP, 2004, available at http://www.chimneycaps.com/Final%20images/trubshoot.pdf, ‹Accessed on 3 October 2013›

[14] The Official Guide to HETAS Approved Products & Services, Hetas, 2013, available at http://www.hetas.co.uk/professionals/hetas-guide-2013/, ‹Accessed on 3 October 2013›

[15] Technical Guide to the CE Mark, Dinak