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NEFFIS

Development of VET Training on Energy Efficient Stoves and Fireplaces

Air supply for combustion in the heat sources of manual assembly

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Overview

- For what it is necessary to supply air for combustion from the outside
- Examples of air supply from the outside
- Combustion air requirements
- Pressure loss through door frames
- Construction features
- Dew point and insulation
- Sizing of blow holes

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Air supply for combustion

- For what it is necessary to supply air for combustion from the outside
  - Previously: a large number of leaks through the building envelope
    → the required amount of air for combustion is not a problem
  - Currently: well insulated building envelope
- Open window leads to significant energy loss!
- In modern buildings, the air for combustion should always be supplied from the outside when applicable!

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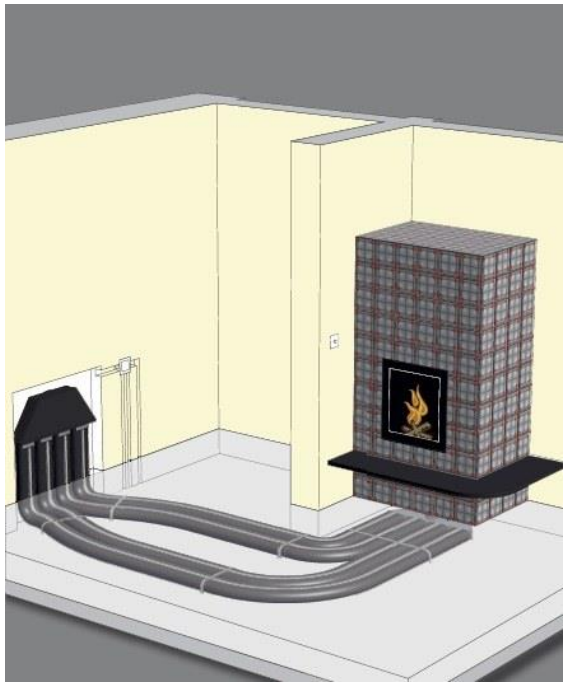
Air supply for combustion

Air supply for combustion from the outside through: channels in the floor construction

Embodiment:



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Air supply for combustion

Air supply for combustion from the outside through: inlet air shaft integrated in the chimney system

Embodiment:

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Air supply for combustion

- What air consumption for combustion is required in a tiled stove?
- – Minimum air requirement:
- 4 m^3 of air per 1 kg of wood
  - Excess air ratio: about 3
  - Actual air requirement: 12 m^3 of air per 1 kg of wood
  - With a fuel consumption of 10 kg/h → the air consumption for combustion will be about 120 m^3/h
  - Air flow rate for combustion = Volumetric air flow rate / Section area (@ d = 10 cm, 120 m^3/h → 4.2 m/s)

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Air supply for combustion

- Volumetric flow rate of air for combustion at 12-hour rated heating time:

Rated power	Maximum amount of fuel	Volumetric air consumption for combustion	Velocity for pipe ∅10	Velocity for pipe ∅15
kW	kg	m^3/s	m/s	m/s
1.6	6.0	56	2.0	0.9
2.0	7.4	69	2.4	1.1
2.5	9.2	86	3.1	1.4
3.0	11.1	104	3.7	1.6
3.5	12.9	121	4.3	1.9
4.0	14.8	138	4.9	2.2
5.0	18.5	173	6.1	2.7
6.0	22.2	207	7.3	3.3
7.0	25.8	242	8.6	3.8
3.0	29.5	276	9.8	4.3
9.0	33.2	311	11.0	4.9
10.0	36.9	346	12.2	5.4

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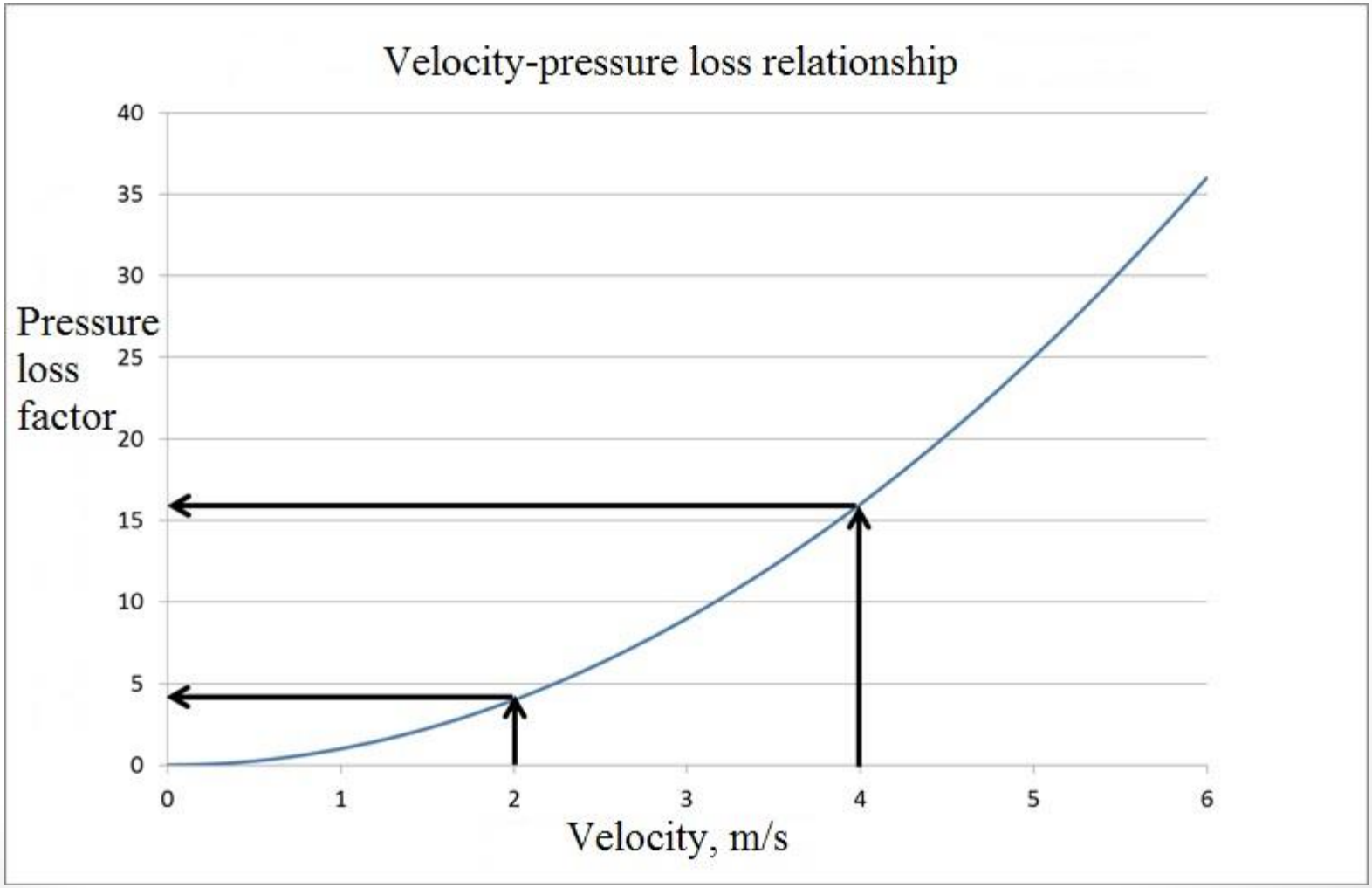
Air supply for combustion



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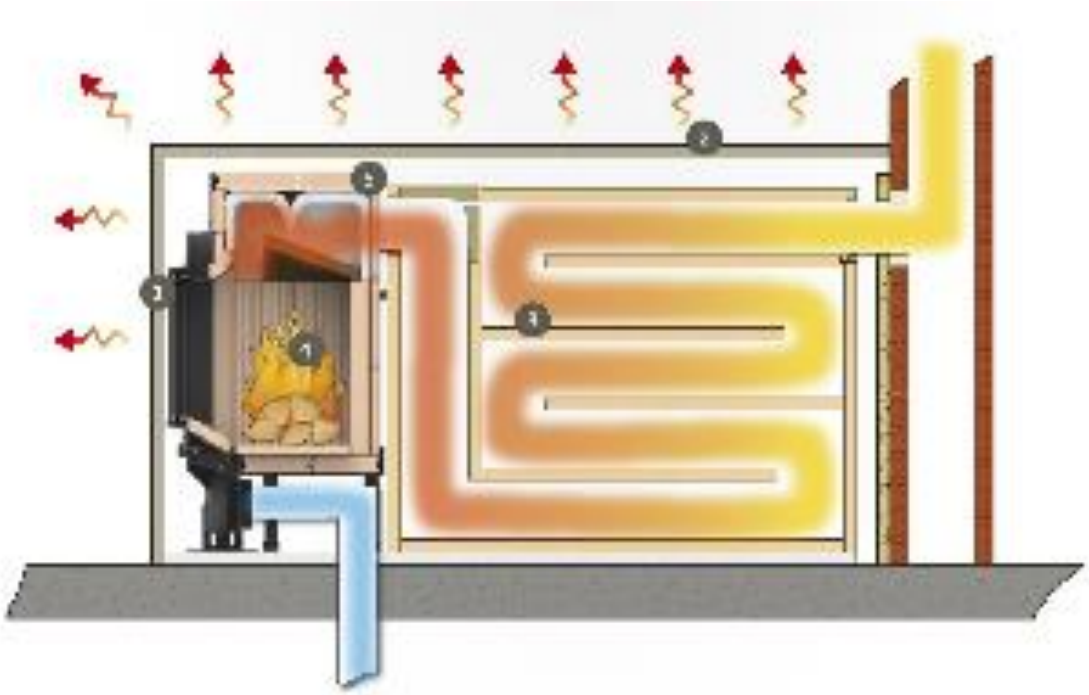
- Example: pressure loss through the frame of the door with the air supply for combustion



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- Example: pressure loss through the frame of the door with the air supply for combustion

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Air supply for combustion

- Estimated dimensions of the flow section for the supply of air for combustion (tiled stove)

Maximum amount of fuel (kg)	Required section A for velocity V > 2 m/s (cm^2)	Estimated pipe diameter (mm)	Actual section A (cm^2)	Estimated dimensions of rectangular section (mm)	
				h	b
5	70	100	79	80	90
6	84	100	79	80	110
7	98	125	123	80	130
8	112	125	123	80	150
9	127	140	154	80	170
10	141	140	154	80	190
11	155	150	177	80	210
12	169	150	177	80	230
13	183	160	201	80	260
14	197	160	201	80	280
15	211	180	254	80	300

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Air supply for combustion

- Estimated dimensions of the flow section for the supply of air for combustion (tiled stove)

Maximum amount of fuel (kg)	Estimated dimensions of rectangular section (mm)		Estimated dimensions of rectangular section (mm)		Estimated dimensions of rectangular section (mm)	
	h	b	h	b	h	b
5	40	210	60	130	100	80
6	40	260	60	150	100	90
7	40	310	60	180	100	110
8	40	360	60	210	100	120
9	40	420	60	240	100	140
10	40	470	60	270	100	150
11	40	530	60	300	100	170
12	40	590	60	340	100	180
13	-	-	60	370	100	200
14	-	-	60	400	100	210
15	-	-	60	440	100	230

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Air supply for combustion

- Pressure losses grow as the square of the flow rate!
- Calculate section as large as possible!
- Avoid narrowing the section! Narrowing can cause much more pressure loss than in the whole air shaft!
- Narrowing comparison:
  - The furnace is designed for a section d = 18 cm
  - The furnace is installed with a section d = 10 cm
  - The furnace will not operate!

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Air supply for combustion

- Construction features
  - Materials
    - polymers
    - metal
    - wood
    - ceramic materials
    - concrete
    - autoclaved aerated concrete
  - During installation, the requirements for bearing capacity and fire protection must be observed!

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Air supply for combustion

- Construction features
  - Insulation of the air channel for combustion
    - Purpose: avoid condensation on the external surface
    - Execution condition: external surface temperature > dew point temperature
    - Dew point temperature: depends on relative air humidity and room temperature
    - External surface temperature: determined by calculation (or in accordance with the technical passport) → Insulation is the most important factor!

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Air supply for combustion

- Example (calculation in accordance with the technical data)
  - Channel material = aluminum (thickness = 1 mm, thermal conductivity = 220 W/m · K)
  - Insulation with a thermal conductivity of 0.04 W/m · K

	External surface temperature (°C)		
Insulation thickness	**Air temperature for combustion = 0 °C**	**Air temperature for combustion = -5 °C**	**Air temperature for combustion = -10 °c**
0 st	1.70	-2.92	-7.55
1 st	15.53	13.91	12.29
2 st	18.47	17.49	16.50
3 st	19.75	19.05	18.34
4 st	20.47	19.92	19.37
5 st	20.92	20.47	20.02

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Air supply for combustion

- Proposals for insulation size
  - Layer 2 cm thick with a thermal conductivity of 0.04 W/m · K is usually sufficient
  - The following have a thermal conductivity of 0.04 W/m · K:
    - Mineral wool
    - Foamed products (e.g. Thermaflex)
    - Polystyrene insulation
  - Insulation must be vapor proof in any case!
  - At very high relative humidity of air thickness of the insulation layer should be determined by calculation.

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Air supply for combustion

- Equivalent material thicknesses (for insulated aluminum pipe)

Material	Thermal conductivity coefficient λ	Insulation 1 cm (λ = 0.04 W/m·K)	Insulation 2 cm (λ = 0.04 W/m·K)	Insulation 3 cm (λ = 0.04 W/m·K)	Insulation 4 cm (λ = 0.04 W/m·K)	Insulation 5 cm (λ = 0.04 W/m·K)
		Comparable thickness				
	W/m·K	cm	cm	cm	cm	cm
Firewood	0.17	4.3	8.5	12.8	17.0	21.3
Brick	0.70	17.5	35.0	52.5	70.0	87.5
Furnace chamotte	0.93	23.3	46.5	69.8	93.0	116.3
Concrete	2.10	52.5	105.0	157.5	210.0	262.5
Cellular concrete (700 kg/m^3)	0.20	5.0	10.0	15,0	20.0	25.0
Calcium silicate	0.06	1.5	3.0	4.5	6.0	7.5
Vermiculite	0.14	3.5	7.0	10.5	14.0	17.5

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Air supply for combustion

- Construction features
  - Combustion air supply valve
    - Tightly closed valve that closes the air supply channel after combustion of the fuel. It is required for installation!
    - There is no mandatory condition where to place this valve: at the end of the combustion air supply channel, or at the point where the channel is connected to the furnace, however, placing the valve closer to the external wall of the building is preferable.

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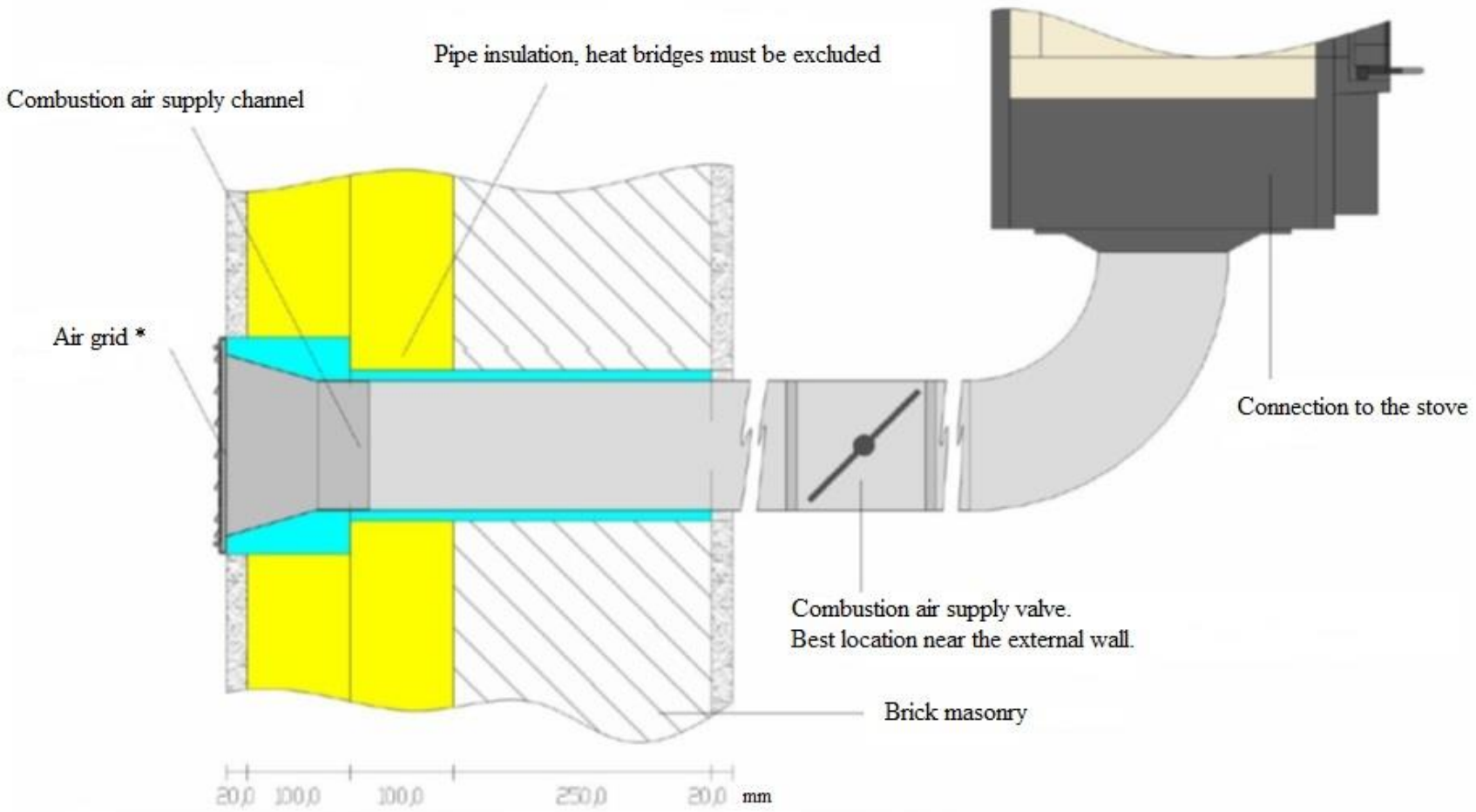
Air supply for combustion



* The air grid should have a equal flow cross-section with the combustion air supply channel, when applicable, in order to keep the pressure loss at a minimum.

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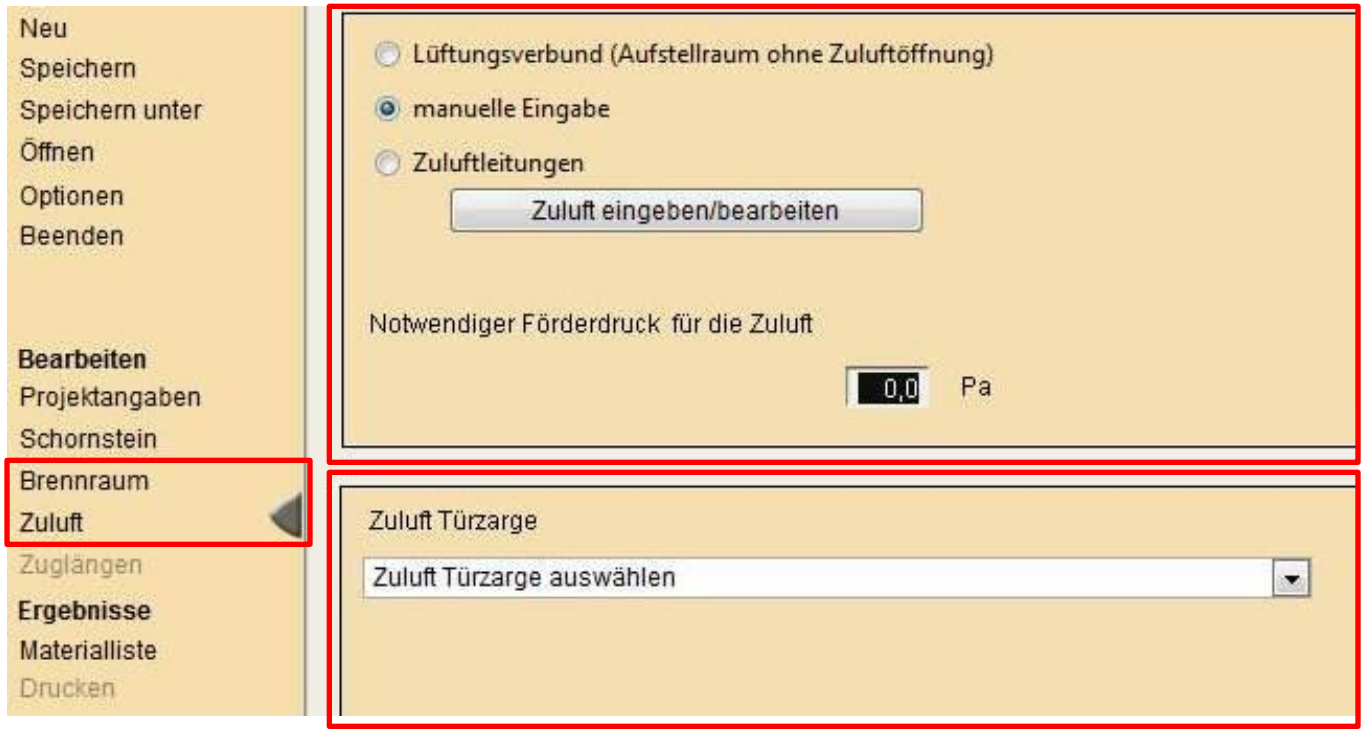
Modern application for the calculation of the tiled stove – air supply for combustion



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Approximate calculation

Basic instructions:

- Few turns, short channel length – about **13 cm^2/kg of firewood**
- Calculation with this value should be performed – about **15-17 cm^2/kg of firewood**
- Many turns and long channel length or elevation above sea level more than 600 m – about **20 cm^2/kg of firewood**
- If you follow these instructions, you will get low pressure losses.

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Development of VET Training on Energy Efficient Stoves and Fireplaces

No 2016-1-LT01-KA202-023161

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Wolfshöher TONWERKE	**Wolfshöher Tonwerke GmbH & Co. KG,** Germany	www.wolfshoehe.de
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Development of VET Training on Energy Efficient Stoves and Fireplaces

BUILDING MASONRY HEAT RELEASE APPLIANCES

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What is a masonry heating stove?

- The main thing that distinguishes a masonry stove from other wood-fired heating appliances is the ability *to store a large amount of heat*.
- This means that you can *rapidly and cleanly* burn a large charge of wood without overheating your house.
- The heat is stored in the masonry thermal mass, and then slowly radiates into your house for the next 18 to 24 hours.

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Heating GREEN

Main aspects of masonry heating stoves that tie in with green building:

- Greenhouse gas reduction
- Low output capability
- Radiant heat

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Types of masonry heating stoves (1)

Masonry stoves are built for different **purposes**:

- Heating
- Cooking (*cooker, oven, bread baking stove, etc*.)
- Combined (*used for heating and cooking*)
- Sauna stoves

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Types of masonry heating stoves (2)

According to **wall thickness,** masonry stoves are divided into:

- *Thin wall stove* - wall thickness 65 mm, warming up faster, is more lightweight, but the heat is emitted for a shorter time;
- *Thick wall stove* - wall thickness 120 mm and more, suitable for heating permanently inhabited premises, warming up longer and emitting heat for a longer time;
- *Combined stove* - fire box wall thickness ½ brick, other wall thickness ¼ brick.

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Types of masonry heating stoves (3)

Depending on its installation place, a stove can be of a different **shape**:

- Rectangular
- Square
- Round
- Angular (triangular)
- Polygon

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Types of masonry heating stoves (4)

Depending on their **height**, stoves are divided into:

- single storey;
- two storey - two stoves with separate hearths placed on each other.

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Types of masonry heating stoves (5)

Heating stoves, depending on their design, are divided according to:

- **thermal capacity** (the ability to accumulate heat, determined by the stove cooling time and measured in hours),
- **smoke and hot gas flow patterns**,
- **thermal power** (the amount of heat that the stove releases into the room between two heatings in one hour).

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Types of masonry fireplaces

According to the prurpose of their appliance, masonry fireplaces can be divided into:

- **Open fireplaces**,
- **Enclosed fireplaces:**
  - natural heat convection fireplaces
  - forced air conveying fireplaces
  - fireplaces with hot-water inserts
  - heat-storing fireplaces

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Parts of a masonry heating stove (1)

Foundation.

Stoves weighing up to 750 kg (1 m3 of bricks weighs approx. 1600 kg) are built directly on the floor if it is strong enough. A stove with a weight over 750 kg is placed on a foundation, which is inserted into the ground 50-100 cm based on the soil type and the size of the stove. The foundation must be at least 3-5 cm wider than the stove. The foundation is made of stone, concrete or bricks.

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Parts of a masonry heating stove (2)

Ash pit.

An ash pit is a compartment at the base of the stove or fireplace that holds ashes. The ash pit is recessed in masonry or other fire-resistant materials so that hot ashes do not accidentally reach wood or other flammable materials. Therefore, the ash is made as long as possible and cleaned frequently so that it does not get blocked. This is also important because of the air that goes into the combustion process through the ashen grill and the door. The amount of air that gets into the rush is controlled more or less by the door.

https://www.ehow.com/info_12077813_ash-pit-fireplace-for.html

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Parts of a masonry heating stove (3)

Hearth.

This is the place where the fuel is burned. Almost always this is the hottest place of a stove. It is normally made 30-40 cm wide and 40-65 cm long, and must not be lower than 60 cm. The minimum thickness of the exterior wall of the hearth is half the brick (12 cm). In the front, the grate is installed to separate the fire box from the ash pit. A deformation gap of at least 5 mm must be left between the grate and fire box walls to prevent possibble damage to the walls when the grate expands affected by the heat.

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Parts of a masonry heating stove (4)

Flue.

This is a duct, pipe, or opening in a chimney for conveying exhaust gases from a fireplace or stove to the outdoors. The flues make the stove‘s convection system and can be arranged vertically or horizontally. Horizontal flues do not require high draught, but they are more likely to absorb soot, and should be made in narrower stoves. Vertical flues need better draught. The flues differ in their size: the hot gas coming out of the hearth needs a lot of space, so the first flue is made biggest. As the gas moves, it gets cooler and takes up less space, therefore the last flues can be reduced in size.

The temperature of the smoke and hot gas coming from the stove to the chimney is normally around 150 °C. If the temperature is higher, then the flue is too short. If the temperature is lower, it means the flue is too long.

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Metal elements of heating and cooking stoves

	Cast iron (or metal) doors for closing fire box and ash pit.
	Stack damper is meant to seal a stove or fireplace shut when it is not in use. This is necessary so that heated air from your home will not escape up the chimney when the fireplace is not being used.
	Grates are cast iron firebars between the fire box and ash pit, through which ashes fall down, the air constantly enters the fire box , which maintains combustion.
	Cooker is the upper part of a cooking stove.
	Cleanout door is the back door of a stove or fireplace where the rubbish is taken out.

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Masonry materials (1)

	Solid clay bricks are used for the masonry of external walls of stoves and fireplaces, smoke and hot gas channels, chimneys. Most often, the dimensions of the brick are 250x120x65 mm.
	Chamotte (refractory) bricks - withstanding from 1580 ° C to 2000 ° C or even more, are made from fire-resistant clay- chamotte and acquire red or yellowish color when burnt. They are commonly used for the inner lining of stoves.
	Clay mortar Clay is the main building material for stoves and fireplaces. The best mortar is obtained by mixing clay and fine gravel (or sand with small gravel impurities, grain sizes not exceeding 1.5 mm) in a ratio of 1: 1 to 1: 4, depending on the type of clay. Properly prepared mortar does not contain lumps, it is not sticky and can easily be squeezed out of the seam by pressing the bricks.

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Masonry materials (2)

	Powdered mortar clay is mixed with water in accordance with manufacturer‘s requirements and used for building stoves and fireplaces.
	Natural stones are used for building stoves, fireplaces, chimney bases, fireplace decorations.
	Concrete is used for building foundations of stoves, fireplaces, chimneys. Lightweight concrete is used for insulation of chimneys.
	Thermal insulating materials: Solid vermiculite boards; Vermiculite boards are resistant to direct fire and heat effects, have good thermal insulation properties. Used for the installation of fireproof constructions, firewalls and heat chambers of stoves or fireplaces.

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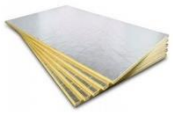
Masonry materials (3)

	Mineral wool is used to isolate the structures adjacent to a stove or fireplace. One surface of the insulating boards must be covered with a heat-resistant aluminium foil. Free air flow must be ensured between the insulation and all heated parts of the stove so that accumulated heat is distributed around the room.
	Waterproofing materials
	Finishing materials – glazed tiles. Made of clay, these decoration elements accumulate heat, provide extra durability to the stove‘s masonry, and cover the cracks in the masonry seams, thus preventing the fumes penetration into the room. The most common types of tiles are glazed, terracotta, porcelain and earthenware. The facade side of glazed tiles is covered with a special enamel - majolica, free from harmful chemicals. The surface of terracotta tiles made of red clay is not glazed. The porcelain and earthenware surfaces are covered with colored glazes. According to their shape and size, the tiles of one set are divided into angular, flat, cornice, shaped and plinth.

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Masonry materials (4)

	Finishing materials - plaster. Heat resistant. One layer can be applied, but it is better to apply it in several layers. Some parts of the stove can become hotter than the others. Cracks appear in the connections at these spots. Additional tools should be used, e.g. latex fabric, wire net or ceramic grid.
	Finishing materials - plaster.
	Fastening elements are steel bars, soft wire, steel staples.

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Stove builder‘s Tools (1)

	The measuring tape (rolling or folding) is used for every precision requiring task.
	Square tool is used for checking the correctness of right angles.
	Level is used to check whether a surface is horizontal or vertical.
	Plummet is used to check the verticality of angles, walls and chimneys .
	Mason‘s hammer is used to chip off edges or small pieces of stone, cut brick or a concrete masonry unit.

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Stove builder‘s Tools (2)

	Masonry trowel is used in brickwork or stonework for leveling, spreading and shaping mortar or concrete.
	Nipping pliers are used for cutting, twisting, bending hardened wire when putting tiles or making loops.
	Rubber hammer is used to fix the position of bricks when building a heat release appliance.
	Electric mixer –is used for mixing mortar or glue.
	Stone cutting machine is used for cutting ceramic and chamotte stones.

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Stove builder‘s Tools (3)

	Fretsaw is used for cutting thin wooden boards, logs (diameter less than 60 mm)
	Perforator drill is used for drilling holes, screwing/uscrewing bolts.
	Safety goggles protect the eyes against small particles and vapours that can spread when cutting, mixing or performing other works.
	Construction brush is used for application of primer, wetting of masonry
	Sponge is used to remove excess glue, liquid substances, for cleaning various surfaces.
	And other tools and measuring instruments that a stove builder uses in his/her work - a knife, a screwdriver, an angle grinder, etc.

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Designing of a masonry heating stove

Location:

Masonry heating stoves are in fact radiant heaters that deliver most of heat by direct radiation. Therefore, maximum output is achieved when maximum surface area is exposed to the area to be heated.

Sizing:

The stove's dimensions depend on the size of the room. It is calculated that heat amount of 21 kcal is needed to heat 1 m3 of space to + 18°C, when the outside temperature is -30°C. It has been determined experimentally and theoretically calculated, that the stove area of 1 m2 produces 300 kcal/h. Knowing the size of the room to be heated, it is possible to calculate the stove dimensions.

Remember: When calculating the dimensions of the stove, consider the part of the house the stove will be built in. If it is on the north or north-east side, the area of the stove is increased by 10%, in the south-east - by 5%.

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Building of a masonry heating stove (1)

a) Carefully select the bricks and prepare the mortar/clay.

b) Start building a stove only after the roof or temporary roof is installed above the work place.

c) When constructing a stove, in important places (fire box, flue), bricks are firstly selected and placed in dry form in order to adapt to dimensions and bonding.

d) Prior to laying, simple clay bricks must be kept in water for 1-1,5 min.; chamotte bricks are immersed in water in order to wash away dust from them.

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Building of a masonry heating stove (2)

e) Smooth and clean surface of the fire box and flues is obtained by a neat masonry and, after adding 5-6 rows, washing the vertical surfaces with a wet cloth.

f) If the stove is built on the existing foundation, before starting work, it is necessary to check the horizontality of the foundation, dimensional accuracy and rightness of the angles.

g) The metal parts of the stove (doors, grates, dampers, etc.) must be fitted and fastened very carefully and precisely.

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Finishing of a masonry heating stove

Possible finishes for a masonry heating stove include:

- Natural stone
- Tiles
- Glazed tiles
- Brick
- Plaster
- Other

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Development of VET Training on Energy Efficient Stoves and Fireplaces

Building and installation of chimneys

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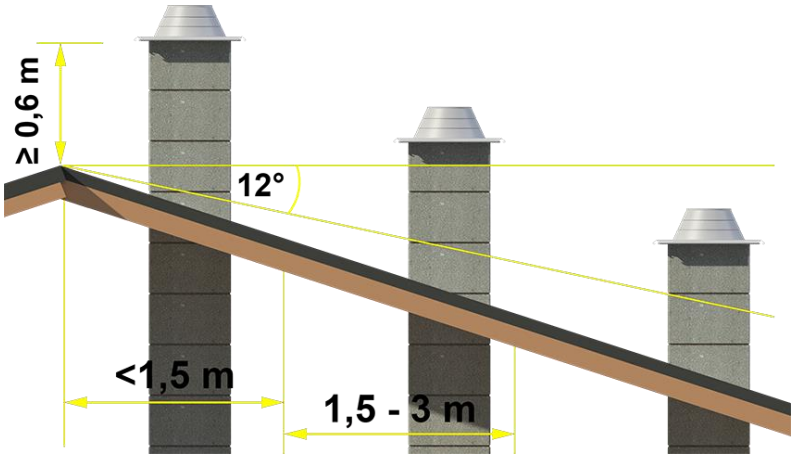
Height of Chimney (1)



The chimney must be raised above the roof at a height that ensures uninterrupted traction and does not pose a fire hazard. The height of a chimney influences its ability to transfer flue gases to the external environment via stack effect.

The height of the chimney must be not less than 0.3 m above the flat roof, parapet or ridge if the surface is not flammable and 0.6 m - if it is flammable. If the roof is flat or its inclining angle ≤ 12 °, regardless of the roof structure, the chimney openings must be at least 0.6 m above the ridge or the edges of the building. If the chimney is constructed > 1.5 m, but at a distance of <3 m to the ridge, the chimney should not be lower than the roof ridge. If the chimney is planned to be installed at a distance of more than 3 m but less than 10 m from the ridge, the height of the chimney must be at least 12 ° from the imaginary boundary of the horizontal line.

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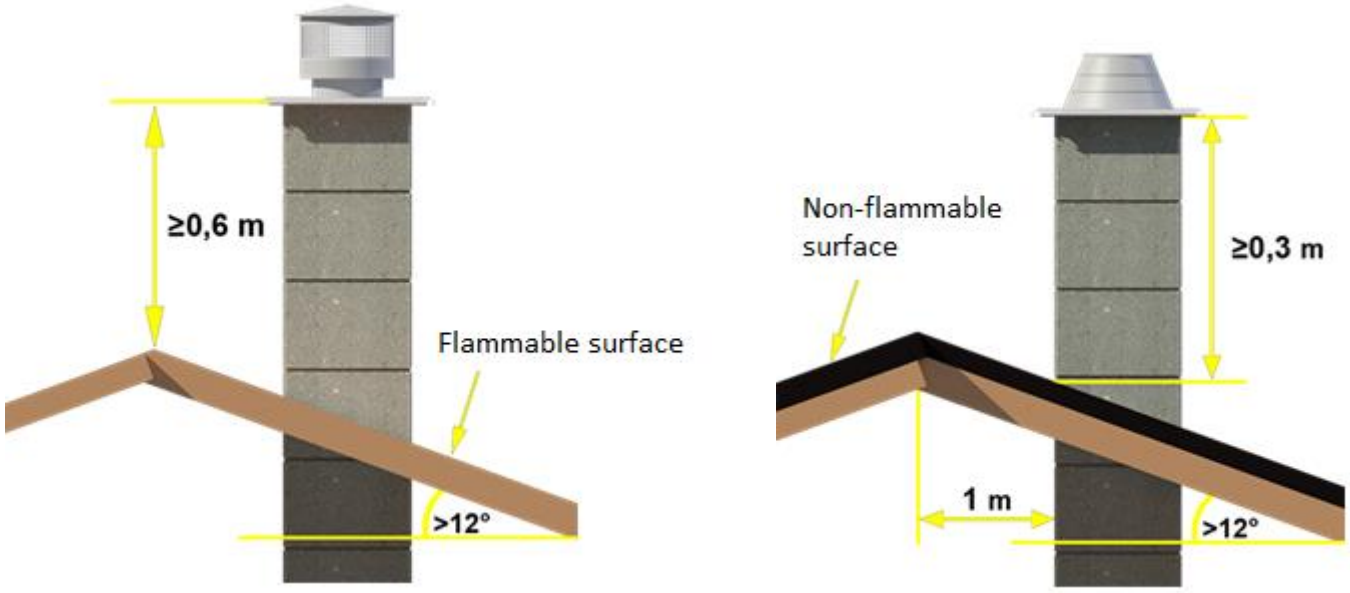
Height of Chimney (2)



When inclination angle of the roof is > 12°, and its surface is flammable, the chimney openings must be at least 0.6 m above the ridge.
In the case of flammable roof surface, spark arresters are installed. Metal nets with openings up to 5x5 mm are used for this purpose.
When inclination angle of the roof is > 12°, and its surface is non-flammable, the chimney openings must be at least 0,3 m above the ridge and at least 1 m away from it.

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Deciding on Chimney cross section (1)

The chimney cross-section is selected according to the technical requirements of the heating appliance manufacturer, depending on the type of fuel, the pressure produced and the heating capacity of the heating appliance, or can be calculated in accordance with the standards.

The chimney cross-section should not be smaller than the cross-section of the connecting pipe for the combustion products of the heating appliance. If several heating units are connected to the same chimney, its cross-section should not be smaller than the cross-sectional area required for the combined heating system.

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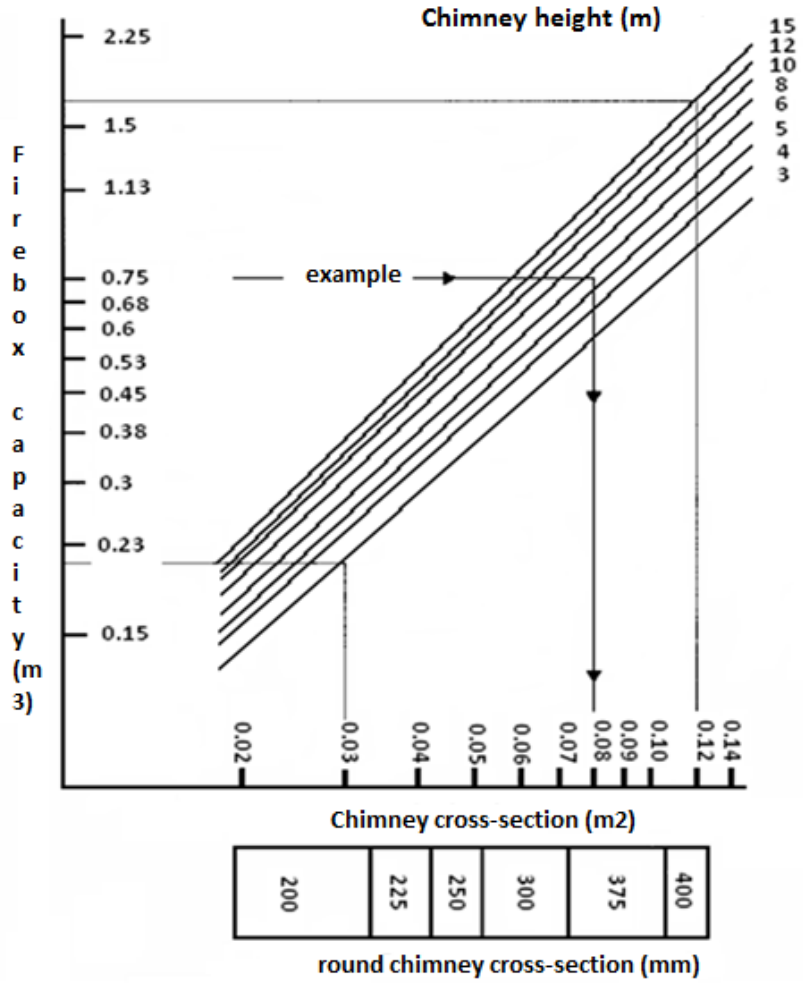
Deciding on Chimney cross section (2)



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Building a Chimney (1)

- The chimney is built carefully from pre-selected bricks or blocks.
- Chimneys can be laid in the wall (in brick buildings), on a separate foundation (in wooden buildings), sometimes installed directly on the stove or fireplace.
- Chimney flue dimensions can be 140x140mm, 140x270mm, 270x270mm. They depend on the type and capacity of the connected heating system.
- It is important to correctly select the flue dimensions because the large cross-sectional flue makes it difficult for the furnace to be fired due to the high cold air pressure.
- In the large cross-section chimney flue, smoke and hot gas flow at a lower speed, so more soot is accumulated on the flue walls.

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Building a Chimney (2)

- The thickness of the exterior walls of the chimney must be ≥ ½ brick.
- Chimney flues must be vertical, without any protrusions, unevenness, as they will accumulate soot and cause worse traction.
- The chimney is built from high-quality, crackless, well-burnt bricks. In the attic clay mortar is used, thickness of joints is up to 10 mm. The smooth side of the brick is laid inside the flue, every 3-4 rows joints are well aligned with a damp cloth.
- Masonry should be made to ensure that the joints are free of cracks, completely filled with mortar.
- When building the chimney extension in the ceiling structure and paving above the roof, bricks are laid with overlap of ¼ of their length, i.e. 60-70 mm, depending on the thickness of the joints.

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Building a Chimney (3)

- Chimney foundation is built separately from the building or stove foundation. They are plunged into the ground to the same depth such as the foundations of the house.
- A clenout door must be installed above the floor level. Each chimney must have separate sealed doors for cleaning.

www.northlineexpress.com

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Installing a Chimney (1)

Modular ceramic chimney system

Concrete products which, in their interaction with moisture, even improve their properties, are the most suitable for outdoor conditions. Meanwhile, clay products, which are most suitable for contact with fire, have no resistance to atmospheric influences. These properties of materials are applicable in the production of two-wall modular chimney systems. The heat and acid-condensate resistant clay insert is put in the outer lightweight concrete block. An additional heat-insulating material is added to them, and an air gap is left to remove moisture, which can accumulate on the clay insert.

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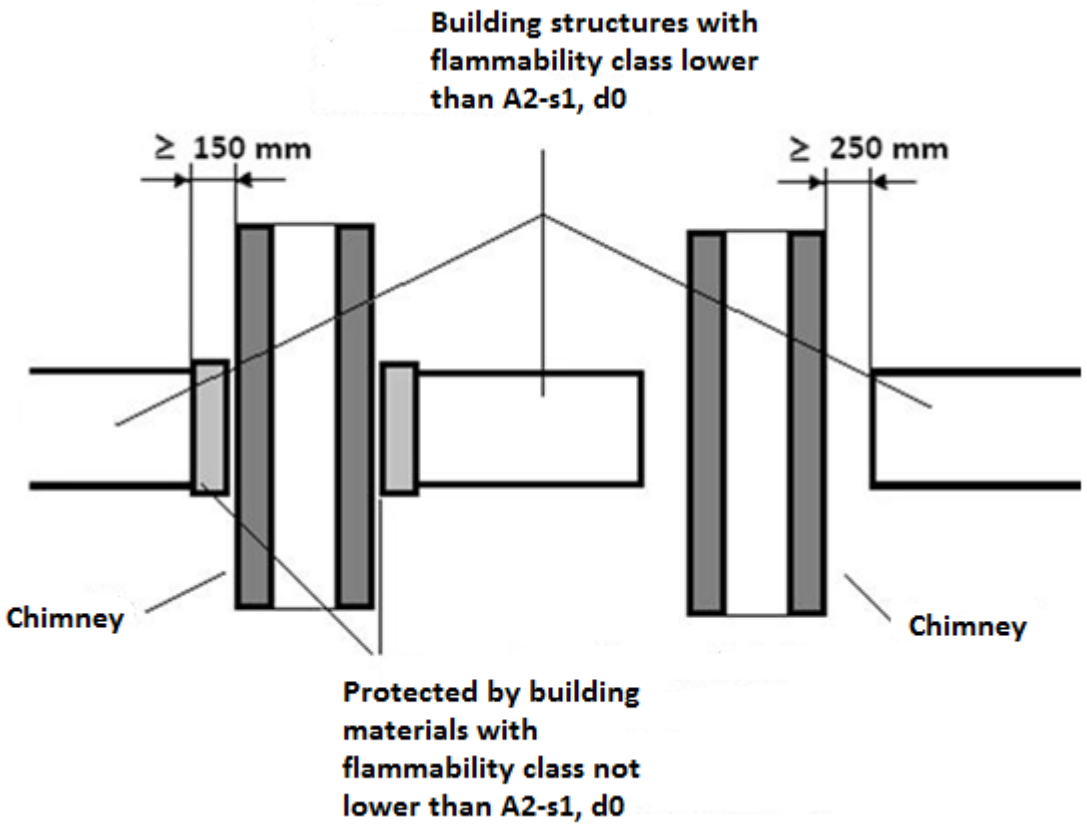
Installing a Chimney (2)

Distance from the exterior surface of the chimney wall to the building structure



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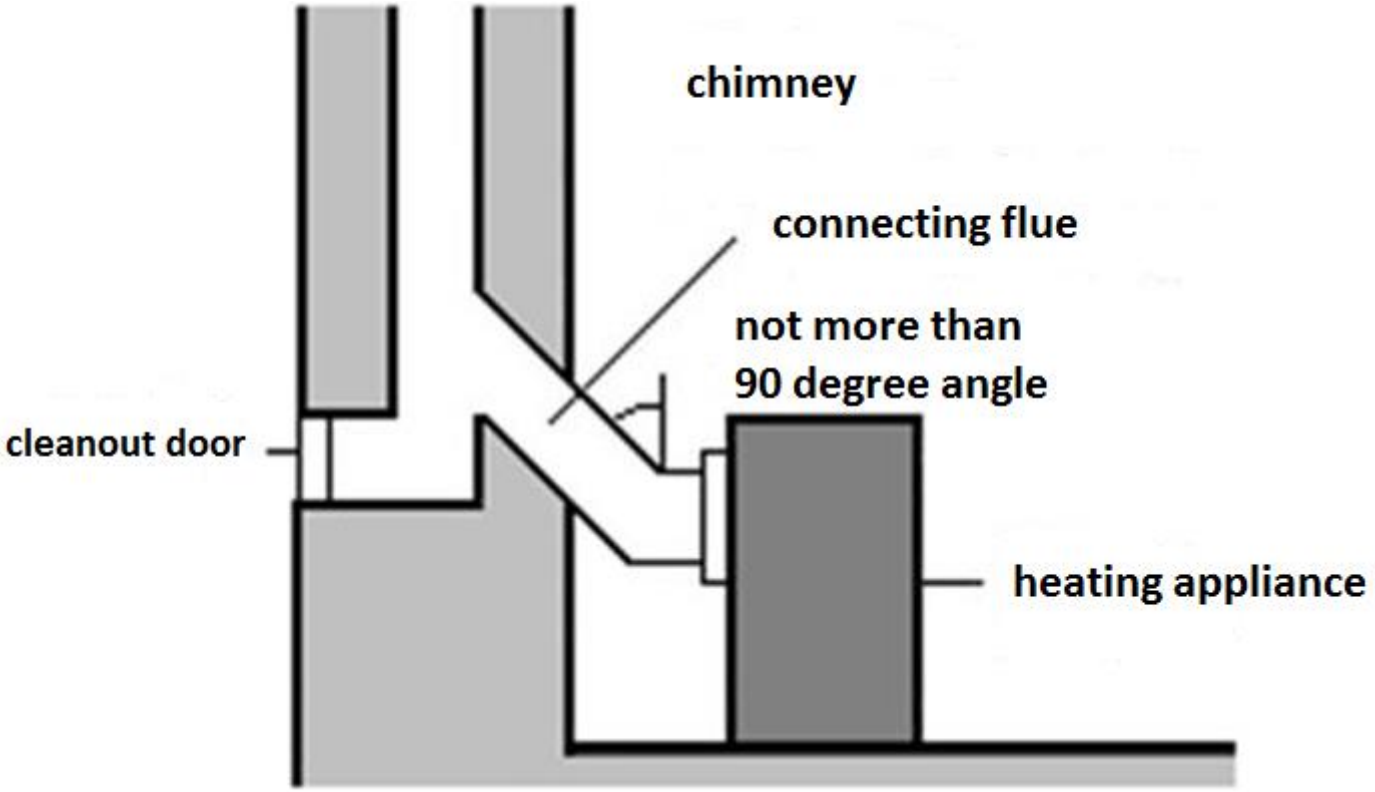
Installing a Chimney (3)

The principle of connecting the chimney to the heating system



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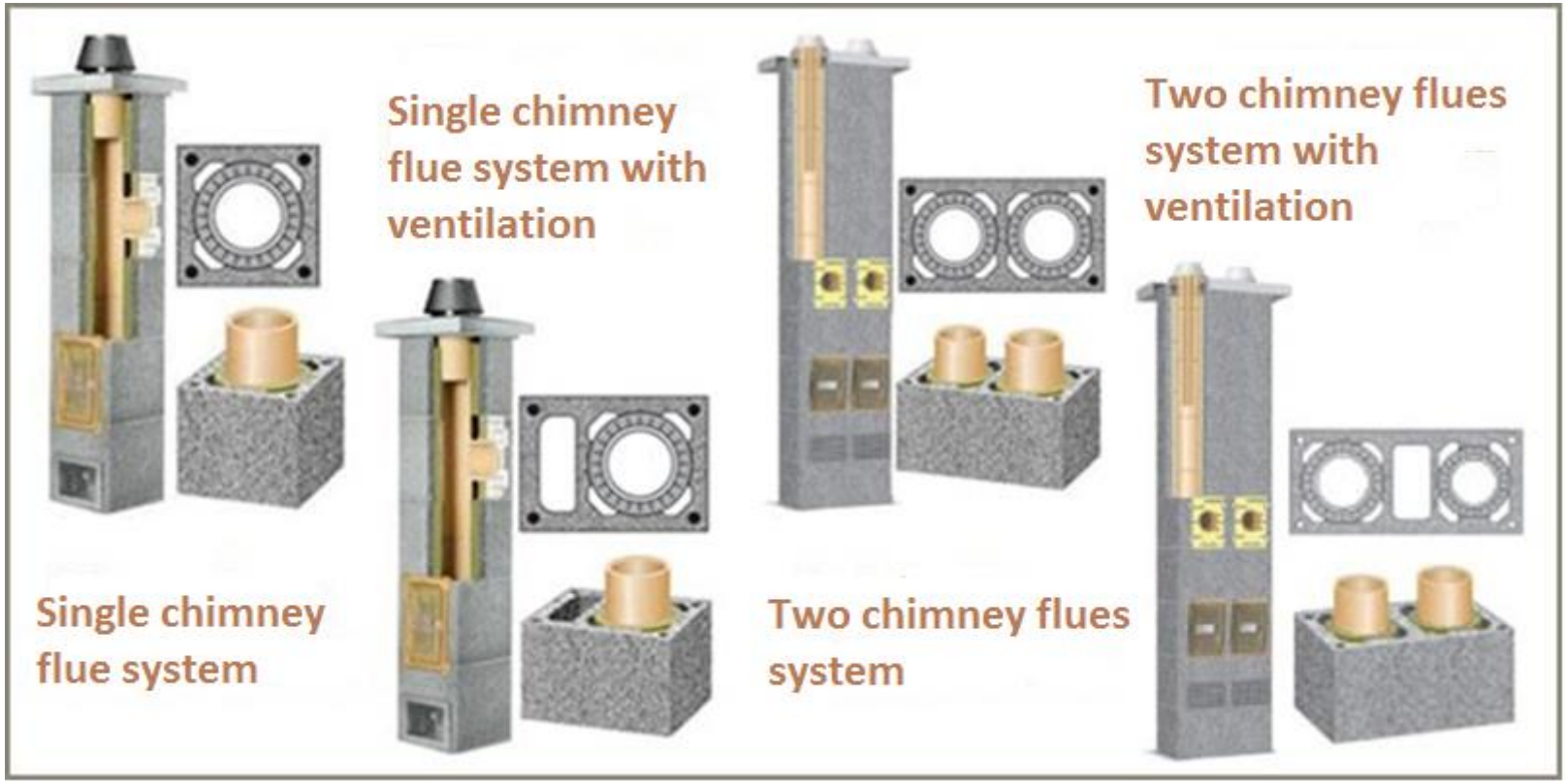
Installing a Chimney (4)

Chimney types



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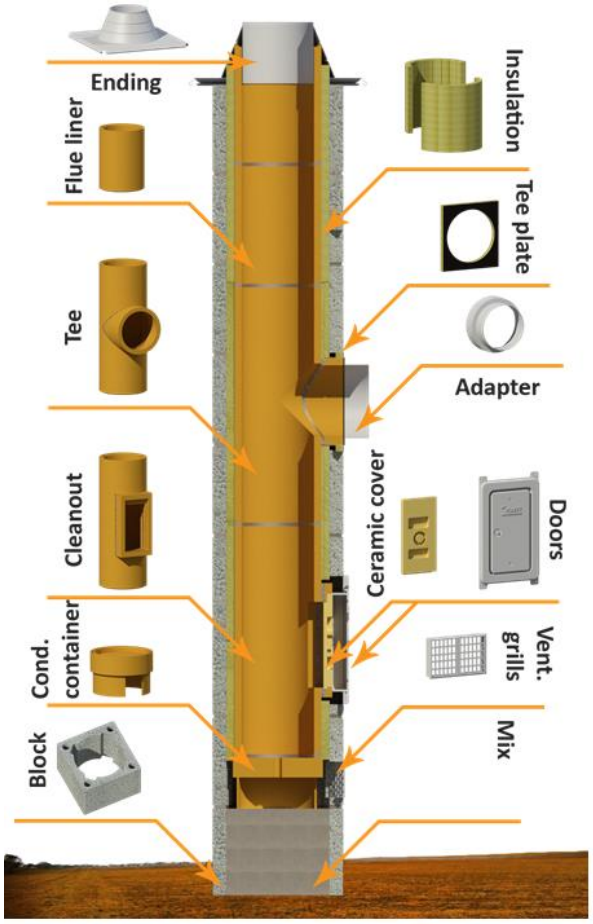
Installing a Chimney (5)

Modular ceramic chimney system is a multi-layered chimney system. It is made of expanded clay blocks, mineral wool and ceramic elements.



http://www.kaminai.com/en/all-chimneys/

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Installing a Chimney (6)

Modular chimney is assembled from pre-fabricated elements.
Ceramic chimney system parts are resistant to soot ignition also low and high temperatures (60oC - 600oC).
Ceramic liner has smooth surface and is highly resistant to condensate effect (resistant to aggressive corrosive factors).
The mineral wool adheres to the ceramic (chamotte) flue liner to ensure thermal insulation of the chimney. The very high thermal insulation wool used does not allow the smoke to cool while increasing the traction. In this way, chimneys produce significantly less condensate and soot.

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Installing a Chimney (7)

The external modular block is made of lightweight concrete with special openings for reinforcement rods. The block helps to center the inner ceramic (chamotte) flue insert and insulating mineral wool layer. An external block can also be used as a building element, which at the end of the installation is usually covered with plaster.

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Development of VET Training on Energy Efficient Stoves and Fireplaces

No 2016-1-LT01-KA202-023161

VILNIAUS STATYBININKŲ RENGIMO CENTRAS	**VSRC** - Vilnius Builders Training Centre, Lithuania	www.vsrc.lt
KROSNIŲ MEISTRŲ GILDIJA	**KMG** – Association of Lithuanian Stove Builders, Lithuania	www.krosniumeistrugildija.lt
Wolfshöher TONWERKE	**Wolfshöher Tonwerke GmbH & Co. KG,** Germany	www.wolfshoehe.de
KVT Kütte- ja Ventilatsioonisüsteemide Teabekeskus	**KVT** - Centre for Adult Education, Estonia	www.kvtkoolitus.ee
SATAEDU	**SATAEDU** – Satakunta Educational Federation, Finland	www.sataedu.fi

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Development of VET Training on Energy Efficient Stoves and Fireplaces

CUSTOMER CONSULTATION

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Customer needs and wishes

- The stove builder has to interview the customer to fix the needs requirements of a specific project.
- It is important to distinguish between needs and wishes
- Stove builder must always keep in mind the fire safety and efficiency of the heating appliance.
- The needs requirements have to be written down and annexed to the contract.
- In case there are alterations to the project during building work this has to be fixed in writing
- When the work is finished the work has to delivered together with documentation. The customer will sign off on the works.

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Types of solid fuel appliances

•In order to advise the customer on the choice of the right appliance the stove builder must know and distinguish between different types of heating appliances.

- Heat accumulation stove
- Hypocaust stove
- Heat accumulating fireplaces
- Cooking stoves and baking stoves
- Fireplace with integrated air ventilation
- Water heating stoves

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Types of solid fule heat appliance – Heat accumulation stoves

- Ceramic stoves, brick stoves and module stoves are all heat accumulating stoves
- The heat accumulating stoves are made of heat storing materials (such as ceramics).
- When heating the stove the heat is stored in the mass of the stove and directed to the room through radiation and convection.
- The heat accumulation stoves are built with or without air gap.

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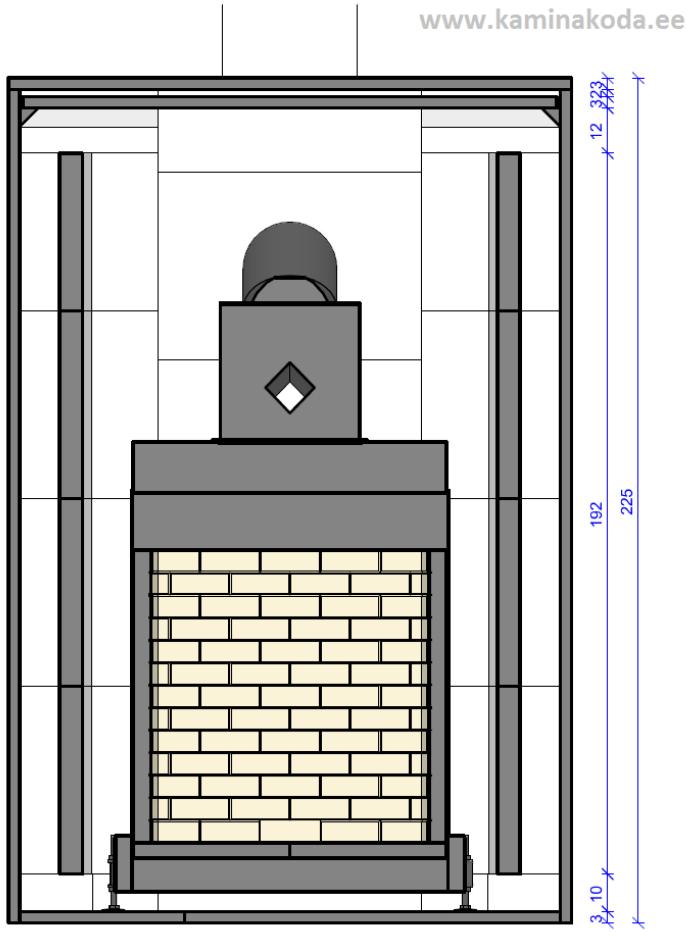
Types of solid fule heat appliance – Hypocaust s

- Hypocaust is a type of convection stove
- Hypocaust stoves have two shells, with an airgap in between.
- The inner shell of the stove is heated.
- The heat from the inner shell is passed onto the outer shell and into the room through convection.



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Types of solid fule heat appliance – Heat accumulating fireplaces

- Heat accumulating fireplace is constructed of a metal insert combustion chamber and heat accumulating outer shell
- In some cases the smoke is directed through heat accumulating modules.
- Usually the weight of the heat accumulating fireplace is between 200-1000 kg

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Types of solid fule heat appliance – Cooking and baking stoves

- Cooking stoves can be built solely for cooking or with a function to accumulate heat as well
- Cooking stoves can have warm wall attached for additional heating
- Cooking stoves can also have a baking function.
- The cooking stove accumulates heat for 4 hours, stove with warm wall/heat accumulation 4-12 hours.

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Types of solid fule heat appliance – Water heating stoves

- Water heating stoves have a pipe system integrated with the combustion chamber for heat exchange
- The heat exchange unit can be placed above the combustion chamber or next to it.
- The heat exchange unit will direct the warm water to boiler and the water can be used for heating the building.
- Depending of the construction of the heat exchange unit 20-50% of the heat produced in the burning process is delivered to water.
- Water heating systems are most often used in combined heating solutions.

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Use of solid fuel appliances – stove as the main source of heating

Main source of heating – the stove is the primary and sole source of heating for the building.

For Example: 2500 kg to 4500 kg massive stoves with heat accumulation period up to 24 hours.

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Use of solid fuel appliances – stoves combined with other heating systems

The heating appliance has an important role in heating of the building, but is used in parallel with another heating appliance for example (heat pump, electricty, central heating)

For example heat accumulation fireplaces, with mass 500-1000 kg and heat accumulation period 4-12 hours.
Heat accumulation cooking stoves, with mass 400 – 1200 kg and heat accumulation period 4-12 hours.
Light stoves with mass 500-1200 kg and heat accumulation period 4- 12 hours.

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Use of solid fuel appliances – stove as the additional source of heating

The heating appliance has emotional value rather than is used as a primary source for heating. In many cases the same appliances as in combined systems but in lighter version.

For example: Open fireplaces, light (metal) fireplaces, baking stoves

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Heat output

- In order to advise the customer on the type of heating appliance the stove builder must
  - Calculate the heat requirement of the building
  - Calculate the amount of fuel (wood) necessary to meat the heating requirement.
  - Calculate the measurements of the heating appliance (combustion chamber and flue length) to meet that reuirement

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Documentation

Documentation given to customer must include:

- **Customer name and address**
- **Type of appliance (main sorce of heat, additional or combined)**
- **Measurements and weight**
- **Description of solid fuel appliance (materials, flue system)**
- **Heat output and heat accummulation period**
- **Fuel to be used and min/max amount**
- **Chimney (materials and flue length and diameter)**
- **Necessary amount of air for combustion**
- **Guarantee**

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Documentation - exploitation

Manuals for stove exploitation and maintenance include:

- **Instructions for first firing**
  - **Amount of wood (fuel)**
  - **Period of firering**
  - **Ignition from the top of fuel**
- **Instructions for use**
  - **Amount of wood (fuel) min/max**
  - **Type of fuel and measurements**
  - **How many loads per one firering**
  - **Period of firering**
  - **Interval between firerings**

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Documentation - maintenance

- Interval of maintenance
  - cleaning the stove of ash
  - maintaining metal parts
  - Cleaning the chimney
  - professional chimney sweeper sevices

In each case the interval of maintenance is determined by the stove builder. The interval depends on the frequency of use and the type of stove/appliance. Minimum average interval for maintenance is once a year.

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European standards

- EN 13229:2005

„Inset appliances including open fires fired by solid fuels – Requirements and test methods“

- EN 13240:2005

„Roomheaters fired by solid fuel - Requirements and test methods“

- EN 15250:2005

„Slow heat release appliances fired by solid fuel - Requirements and test methods“

- EN 12815:2005

„Residential cookers fired by solid fuel - Requirements and test methods“

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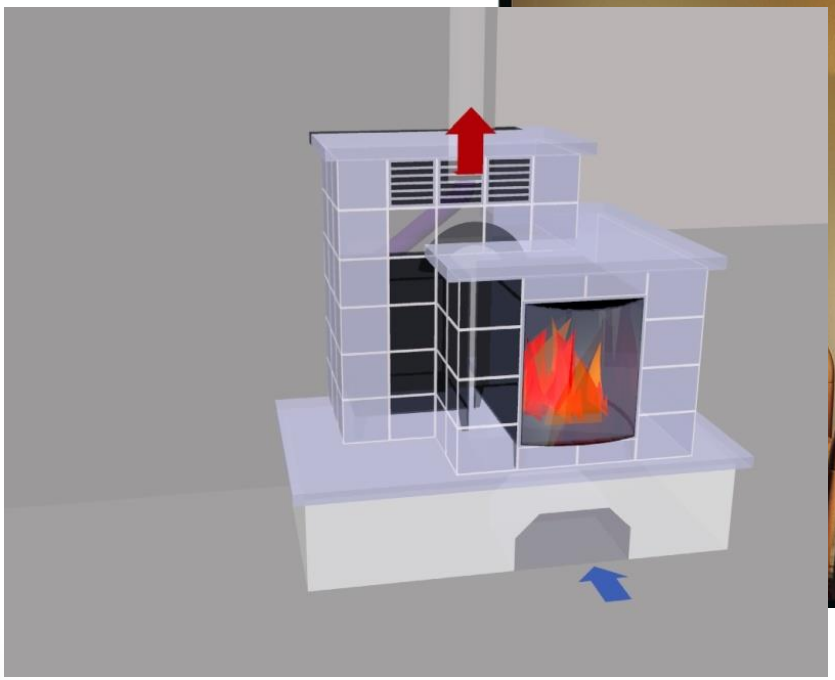
EN 13229:2005

„Inset appliances including open fires fired by solid fuels – Requirements and test methods “



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EN 13229:2005

„Inset appliances including open fires fired by solid fuels – Requirements and test methods "

Provides requirements relating to the design, manufacture, construction, safety and performance (efficiency and emission), instructions and marking together with associated test methods for type testing, residential open fires and inset appliances fired by solid fuel.

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EN 13240:2005

„Roomheaters fired by solid fuel - Requirements and test methods “

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EN 13240:2005

„Roomheaters fired by solid fuel - Requirements and test methods “

Provides requirements relating to the design, manufacture, construction, performance, safety, instruction and marking together with associated test methods and test fuels for type testing residential roomheaters fired by solid fuels.

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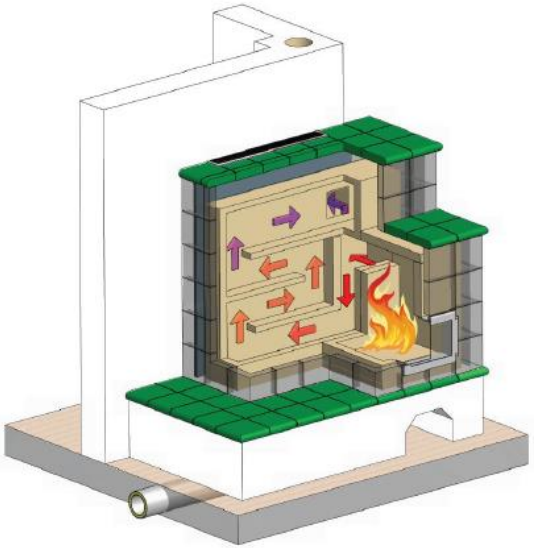
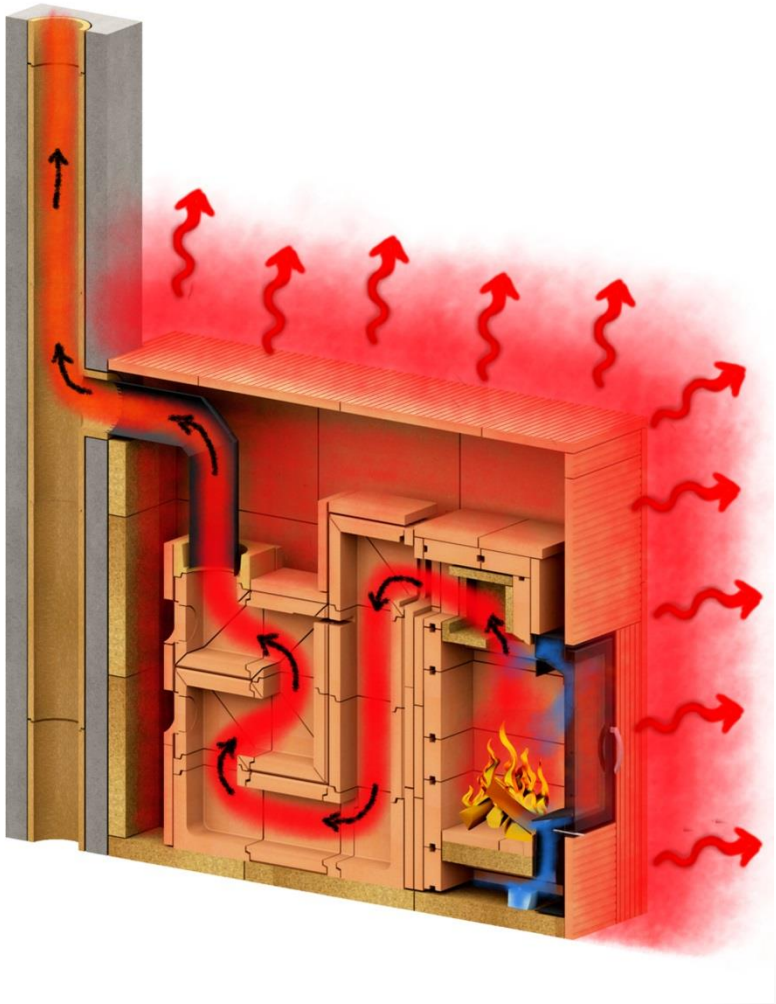
EN15250:2005
Slow heat release appliances fired by solid fuel - Requirements and test methods





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EN 15250:2005

„Slow heat release appliances fired by solid fuel - Requirements and test methods "

Describes requirements relating to the design, manufacture, construction, safety and performance (efficiency and emission) instructions and marking together with associated test methods and test fuels for type testing residential slow heat release appliances fired by solid fuel.

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EN 12815:2005

„ Residential cookers fired by solid fuel - Requirements and test methods “

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EN 12815:2005

„Residential cookers fired by solid fuel - Requirements and test methods “

Describes the requirements relating to the design, manufacture, construction, safety and performance (efficiency and emission), instruction and marking together with associated test methods and test fuels for type testing residential cooking appliances fired by solid fuel.

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Development of VET Training on Energy Efficient Stoves and Fireplaces

No 2016-1-LT01-KA202-023161

VILNIAUS STATYBININKŲ RENGIMO CENTRAS	**VSRC** - Vilnius Builders Training Centre, Lithuania	www.vsrc.lt
KROSNIŲ MEISTRŲ GILDIJA	**KMG** – Association of Lithuanian Stove Builders, Lithuania	www.krosniumeistrugildija.lt
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KVT Kütte- ja Ventilatsioonisüsteemide Teabekeskus	**KVT** - Centre for Adult Education, Estonia	www.kvtkoolitus.ee
SATAEDU	**SATAEDU** – Satakunta Educational Federation, Finland	www.sataedu.fi

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Development of VET Training on Energy Efficient Stoves and Fireplaces

ECO+ stove hearths

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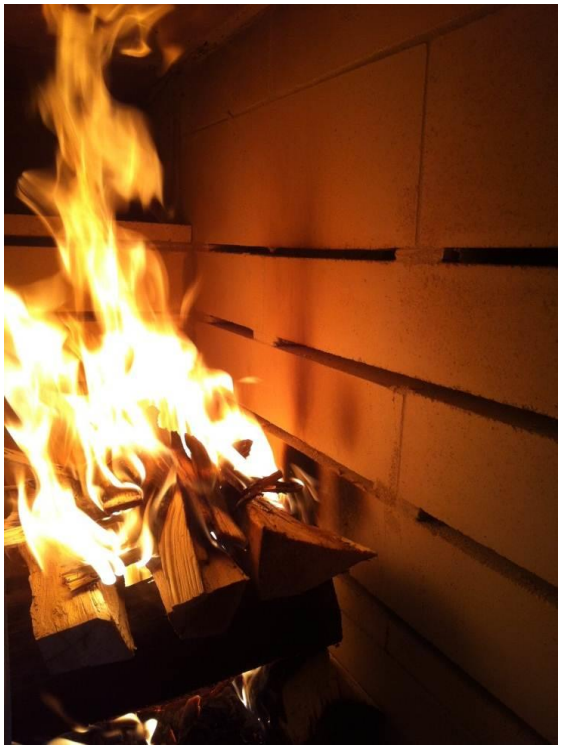
ECO+ stove hearths



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Overview

- Comparison of existing types of fireboxes on emission levels of hazardous substances
- Comparison of emission caps of hazardous substances
- Properties of ECO+ hearths
- Structure of ECO+ hearths
- ECO+ hearth systems that comply with the directive on emission of hazardous substances into the environment

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Comparison of emission levels of hazardous substances by ECO+ and traditional hearths

Property	Tile stove with ECO+ hearth mg/MJ *	Vertical hearth mg/MJ	Horizontal hearth mg/MJ
CO	380	759	870
NOx	82	75	91
Copr	30	68	54
Solid particles	28	17	22
Efficiency factor	80 %	According to the design, but not less than 78%	According to the design, but not less than 78%

* UZ 37 hearths have no emission requirements for partial load.

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Why ECO+ stove hearth?

Emission caps in comparison - hand-built heat sources

Property	Vertical hearth mg/MJ	UZ 37 mg/MJ	§15a BVG mg/MJ	§15a BVG 2015 mg/MJ *
CO	759	700	1100	1100
NOx	75	120	150	150
Copr	68	50	80	50
Solid particles	17	30	60	35
Efficiency factor	According to the design, but not less than 78%	80 %	78 %	80 %

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Features of ECO+ hearths

- Wood-burning stoves with load from 6 to 40 kg
- Corresponding to rated power from 1.6 to 10.8 kW when loaded after 12 hours
- Changes of design and geometry of the hearth are not allowed
- Changes of design and section of channels are not allowed
- As usual, evaluation of the stove is performed using tile stove design software

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Features of ECO+ hearths

- Design changes are possible only in air supply for combustion and in hearth insulation (hearth geometry remains unchanged)
- Absence of differences between horizontal and vertical hearths
- Stove door can be mounted in the hearth both horizontally and vertically.
- As earlier, stove hearth can be assembled manually - use of factory-made hearths is not necessary

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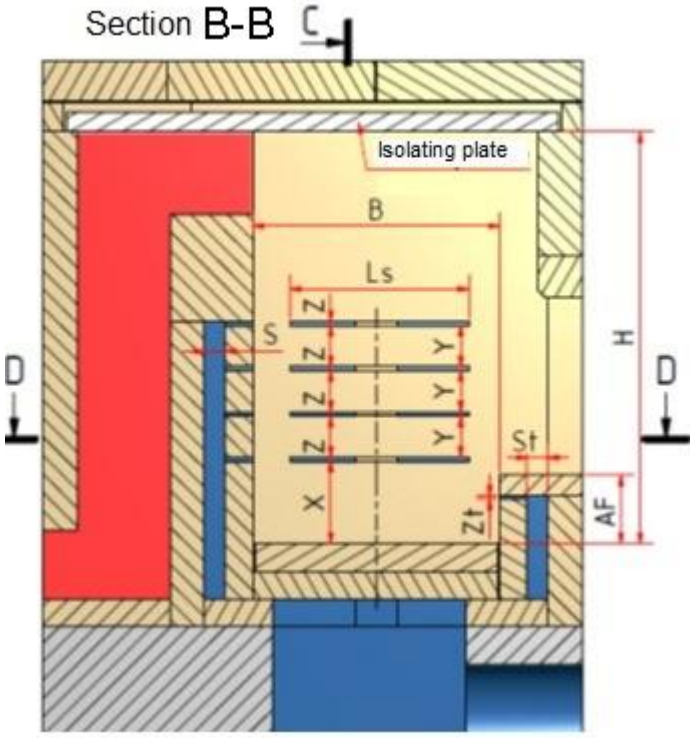
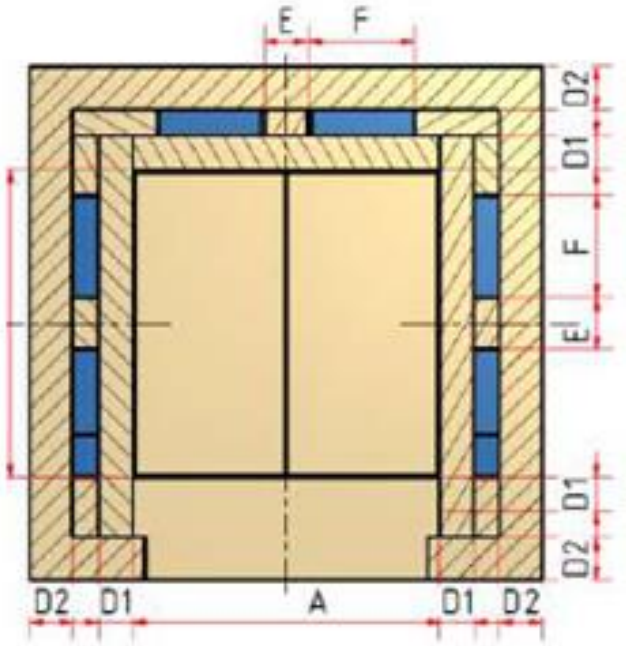
Design





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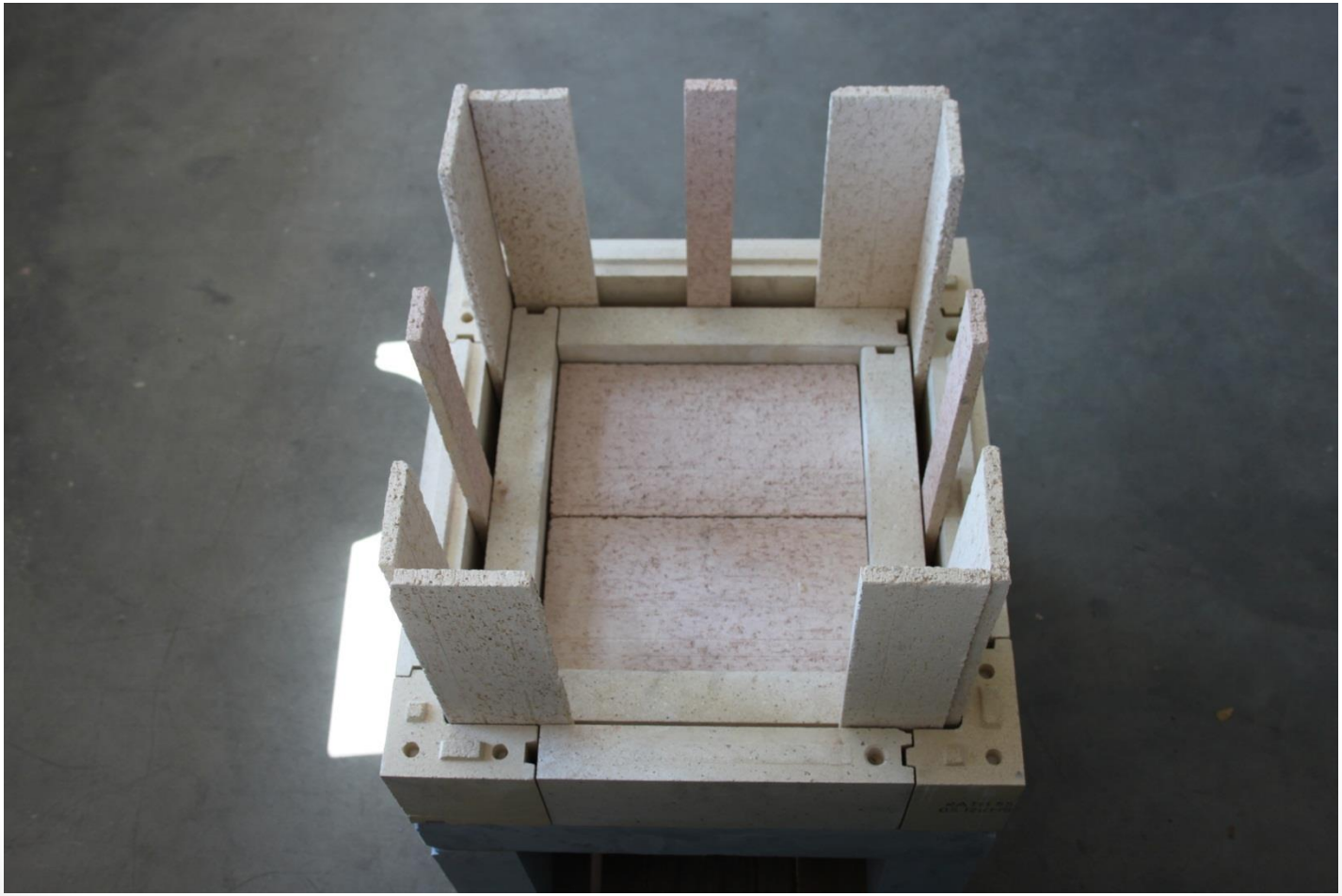
ECO+ hearth: teaching model



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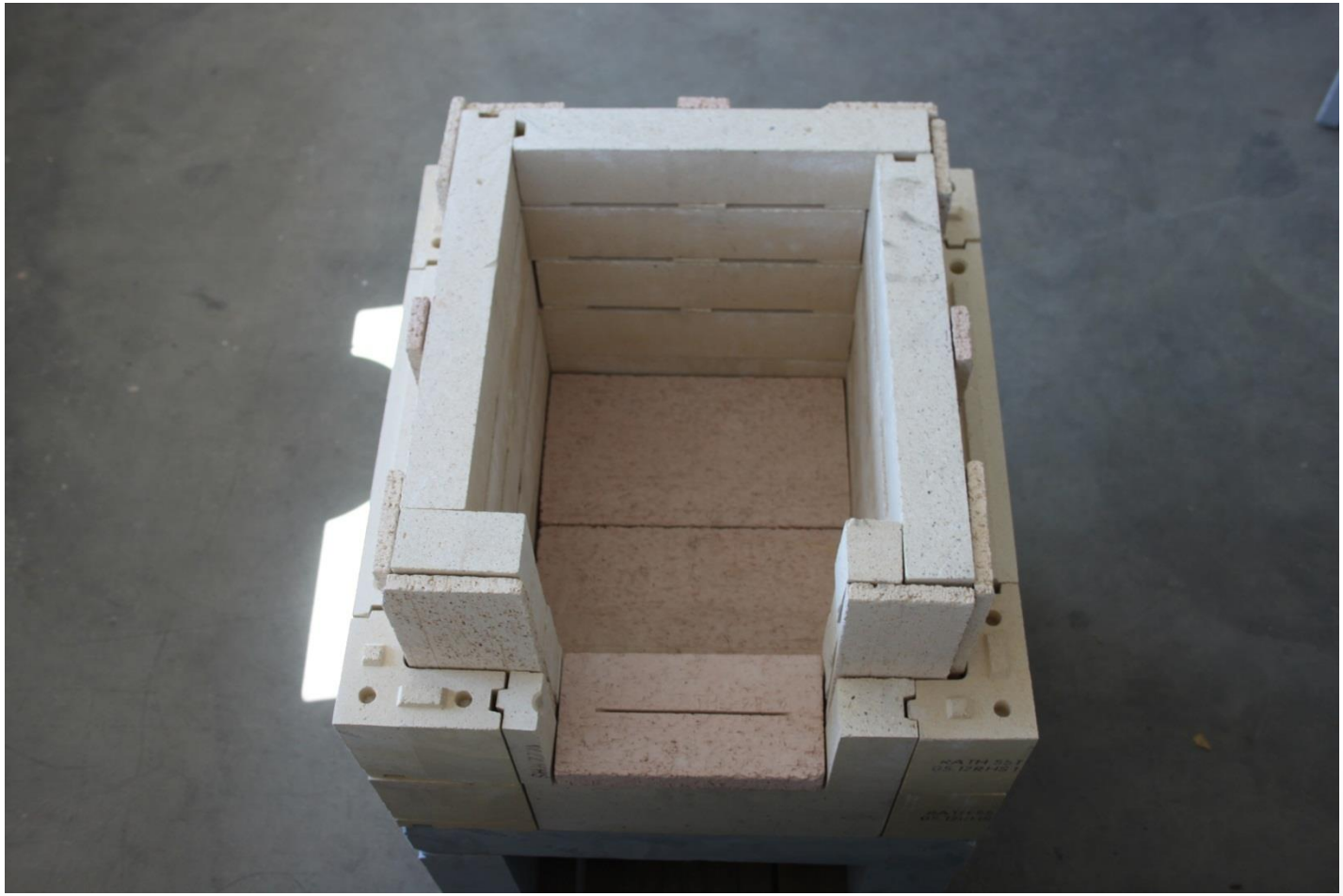
ECO+ hearth: teaching model



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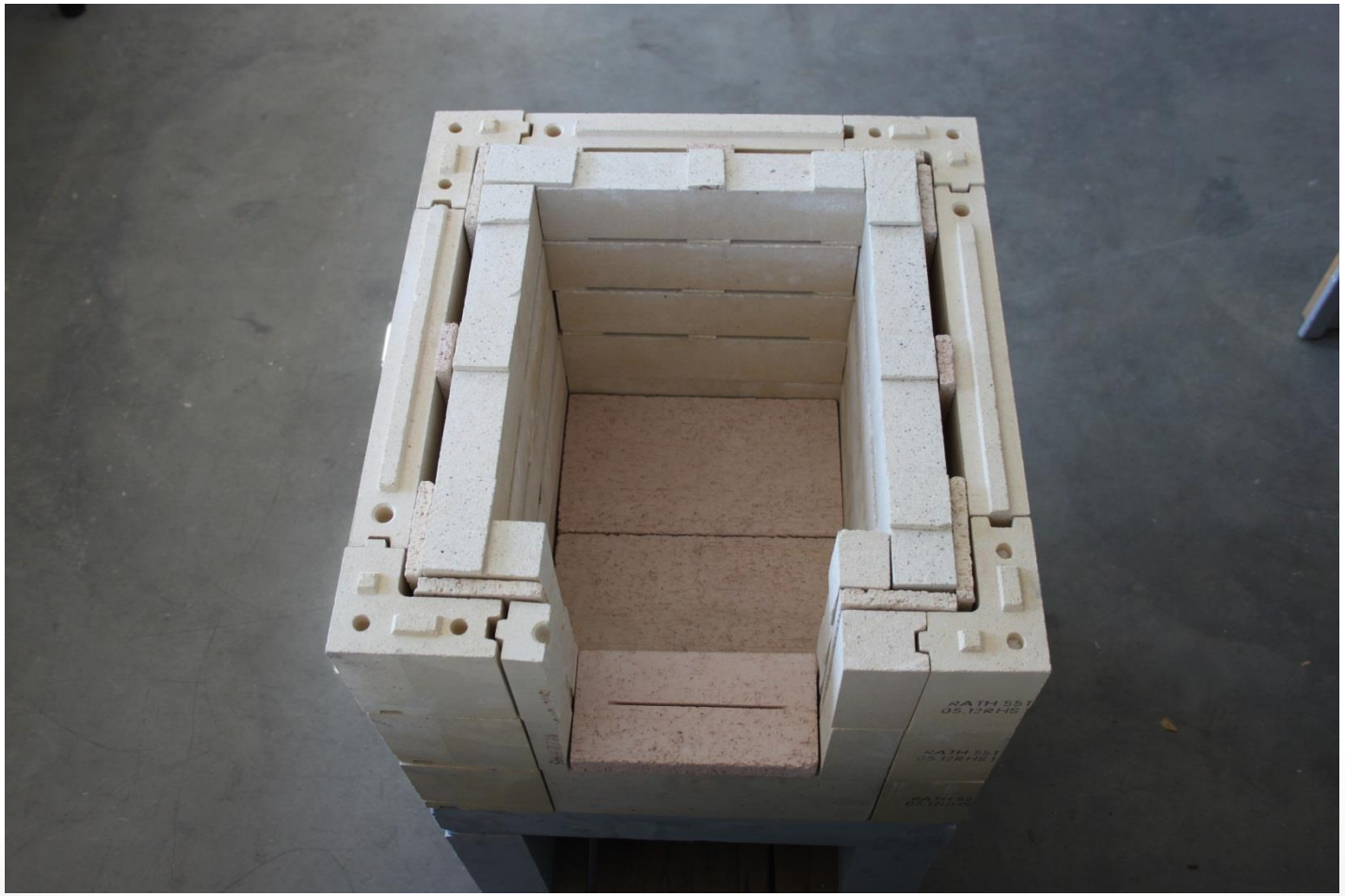
ECO+ hearth: teaching model



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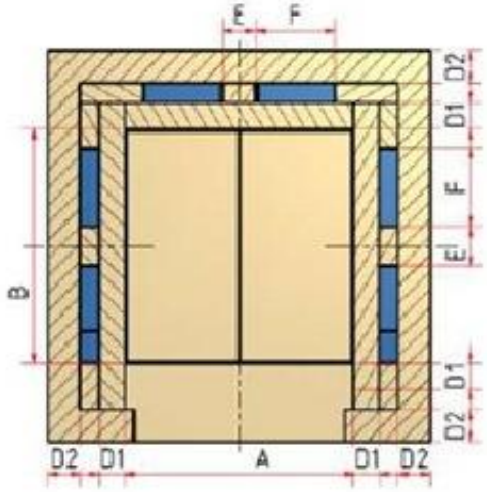
Design

- Installation of ECO+ hearth
  - Design features of geometry of the hearth and arrangement of combustion air supply are implemented in the calculation of tiled stove

3 Hearth design details (from 1.6 kW (6kg) to 6.0 kW (22.2 kg))



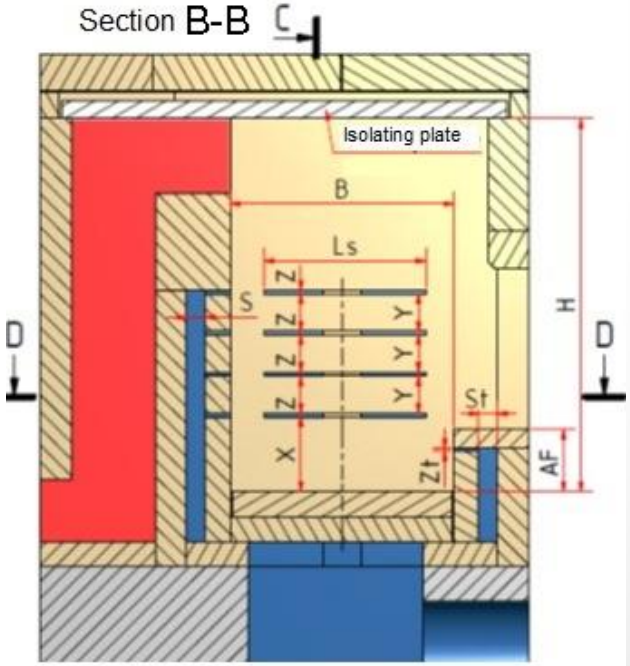
Wall thickness at 1.6 kW (6 kg) - up to 3.5 kW (<12.9 kg)

	min. (cm)	max. (cm)
D1	4	6,5
D2	6,5	8

Wall thickness at 3.5 kW (12.9 kg) - up to 6.0 kW (22.2 kg)

	min. (cm)	max. (cm)
D1	5,5	12,5
D2	6,5	8

Notice: The values provided are based on a nominal time between loads of 12 hours.



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Design

- Installation of ECO+ hearth
  - Space for ash layer with thickness from 5 to 12 cm
  - Minimum height of the hearth: Max. layer of fire wood - 25 + cm.
  - If length of the air intake channel F is > 18 cm, then it is recommended to provide a link between inner and outer walls in rear wall of the hearth.
  - Length of the link E is < than 6 cm.
  - Length of the link cannot overlap more than 20% of length of corresponding link.
  - It is necessary to lay insulating plate freely under the slab of the hearth.

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Design

- Installation of ECO+ hearth:
  - Size and location of air vents for combustion air is calculated using KOK design program.
  - Hearth bottom shall be made of several plates, laid loosely in order to be replaced through the doorway of the hearth. Alternatively, inspection hole can be provided in the pedestal. Such a hole shall be gas-tight.
  - Flue gas outlet can be done through side walls, rear wall or through hearth slab.
  - When using hearth door with air supply to the glass, slots for combustion air supply shall not be located in the same wall as the door.
  - Stove doors with glass can be used provided that corresponding glass occupies not more than 1/6 of inner surface of the hearth.

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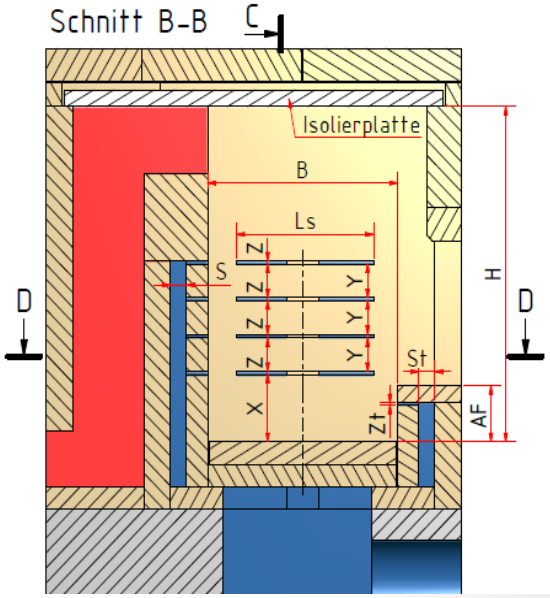
Design

- Installation of ECO+ hearth: rules.
  - Hearth height starts from 40 cm, ash layer thickness starts from 8.5-12 cm
  - The first slot is located 2 cm above the ash layer, the next slot - with an interval (offset) of 8 cm
  - The slot length = (hearth depth/width) – 9 cm, width = 5-7 mm
  - Clear opening of combustion
- air supply hole = 2 cm
  - For the door without air supply to the glass,
- slot length = clear width of frame - 6 cm
  - The slot cross section can be overlapped
- by the link (overlapping shall make not more than 20%)



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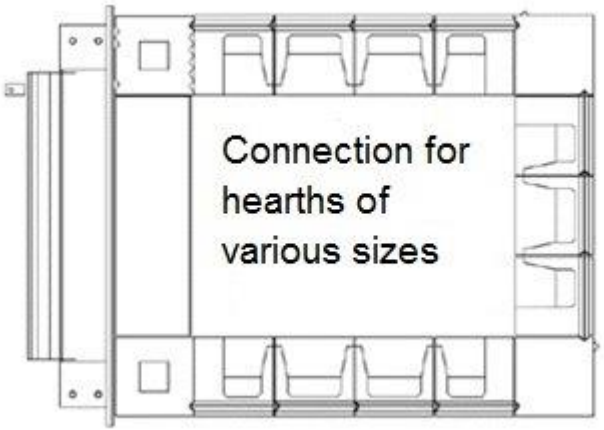
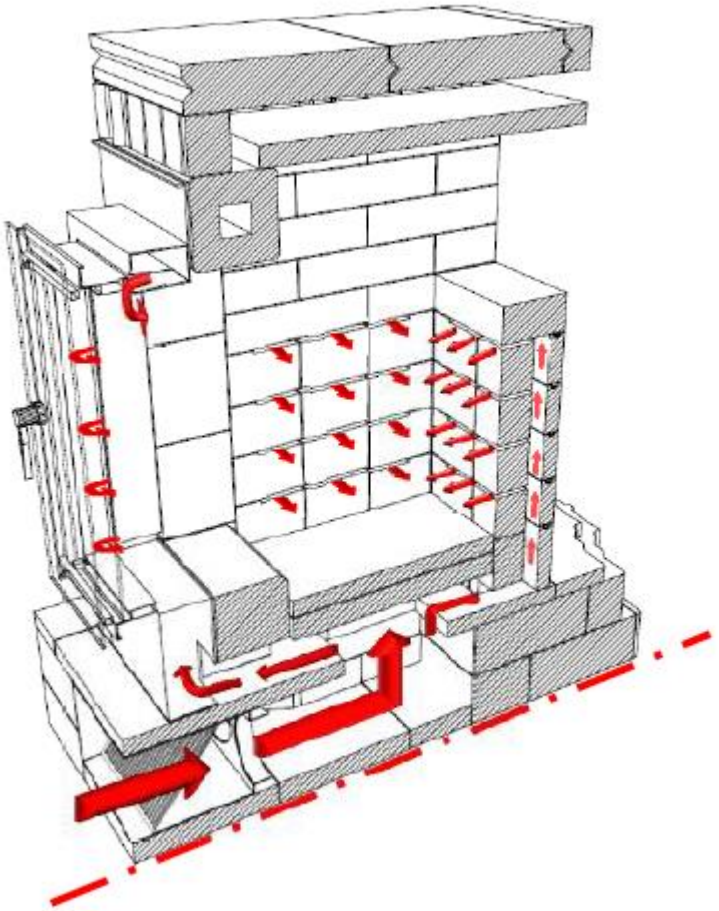
Design style

Section of ECO+ hearth





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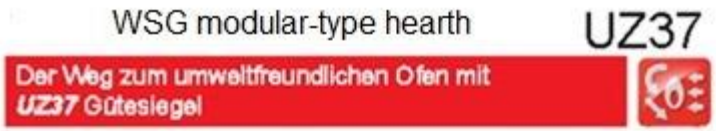
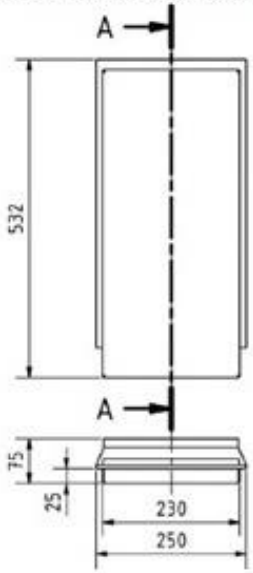
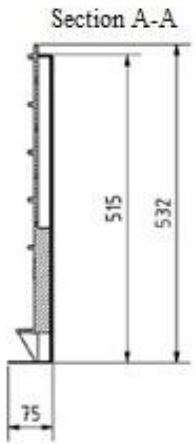
Design style



UZ37 assembly units of WSG hearth: installation dimensic





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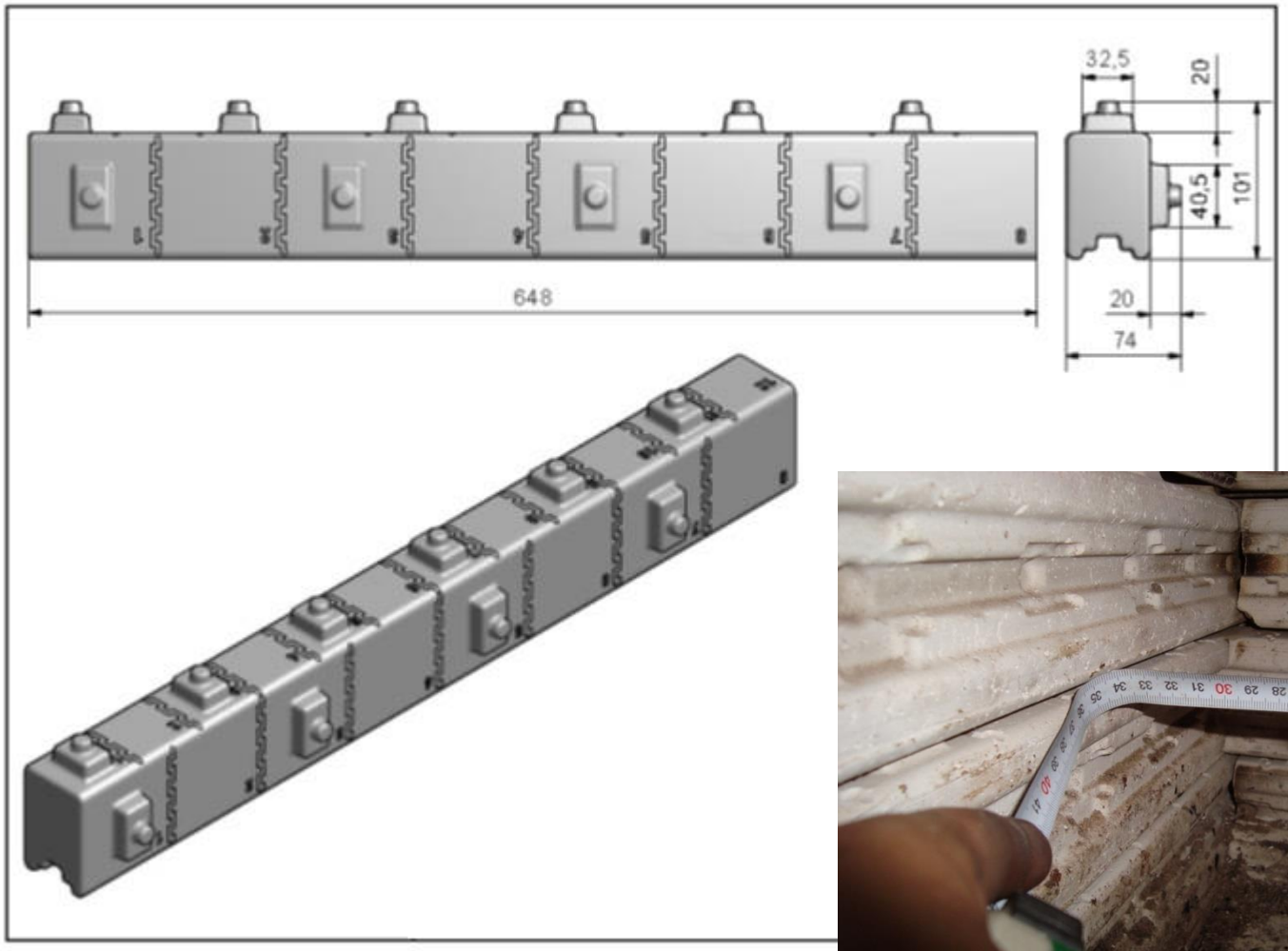
NEFFIS

Design style



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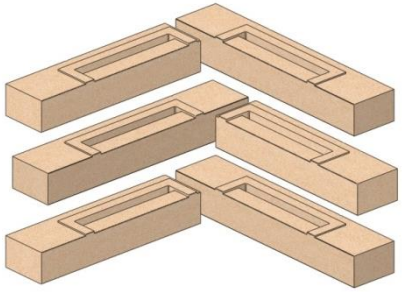
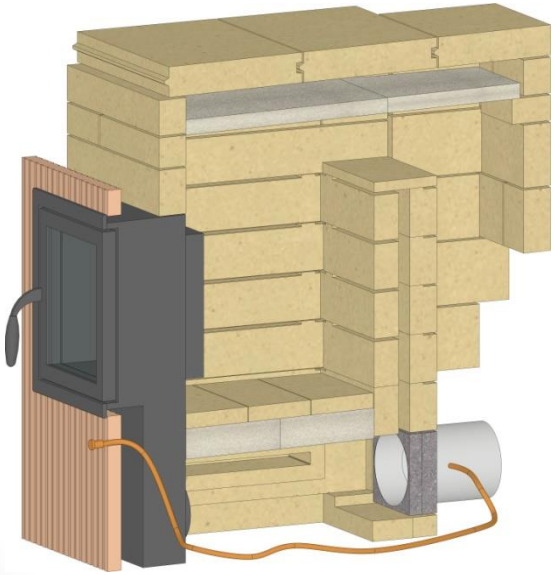
Design style





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Construction

- Installation of ECO+ hearth: hearth walls have slots for combustion air supply (example from practice)

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Development of VET Training on Energy Efficient Stoves and Fireplaces

No 2016-1-LT01-KA202-023161

VILNIAUS STATYBININKŲ RENGIMO CENTRAS	**VSRC** - Vilnius Builders Training Centre, Lithuania	www.vsrc.lt
KROSNIŲ MEISTRŲ GILDIJA	**KMG** – Association of Lithuanian Stove Builders, Lithuania	www.krosniumeistrugildija.lt
Wolfshöher TONWERKE	**Wolfshöher Tonwerke GmbH & Co. KG,** Germany	www.wolfshoehe.de
KVT Kütte- ja Ventilatsioonisüsteemide Teabekeskus	**KVT** - Centre for Adult Education, Estonia	www.kvtkoolitus.ee
SATAEDU	**SATAEDU** – Satakunta Educational Federation, Finland	www.sataedu.fi

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Development of VET Training on Energy Efficient Stoves and Fireplaces

Heat sources in energy efficient houses

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ENEFFIS

Heating with wood in energy efficient houses
Tile stoves, combined stoves, hearths

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Contents

- Application field
- Heat sources in energy efficient houses

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Desire to feast eyes on fire in energy efficient houses

- Safety = power supplier neutrality
- All-in-one
- Comfort and convenience
- Additional heating source
- Ability to get rid of the feeling of coldness quickly

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Implications of modern building construction concept

- Correspondence of heat capacity of firewood heat sources to actual low heating load
  - Low-power stoves as heat sources for one room (small tile stoves, kitchen stoves)
  - Heat load shall be calculated in advance
  - Increases ability to heat multiple rooms
  - Heating with wood in capacity of heat source is very interesting, since the volume of manipulations due to small amount of wood is really small.
  - Heating devices on split firewood and pellets →are dual hearths

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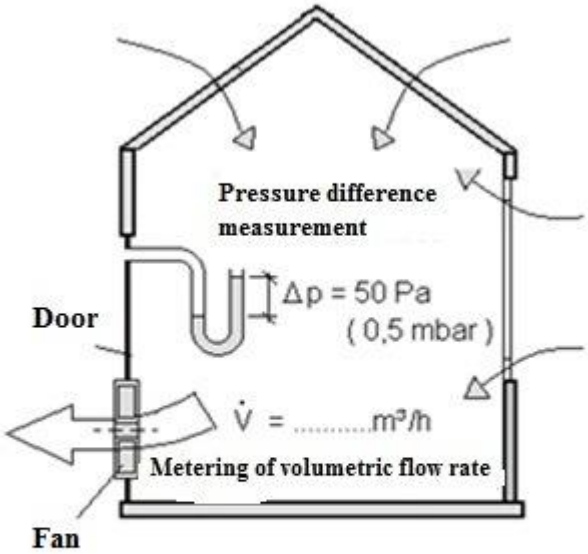
Design solutions - gas-tight execution of the heat source

Houses with low energy consumption require external supply of air for combustion

- Due to high density of passive houses, air for combustion cannot be supplied from a premise
- Air shall be supplied from outside



$$n\,50 = \frac{\text{Volumetric flow rate}}{\text{Building consumption}} \quad [1/h]$$

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Design solutions
- external air supply for combustion

- Houses with low energy consumption require external supply of air for combustion

  – Due to high density of passive houses, air for combustion cannot be supplied from a premise
  – Air shall be supplied from outside

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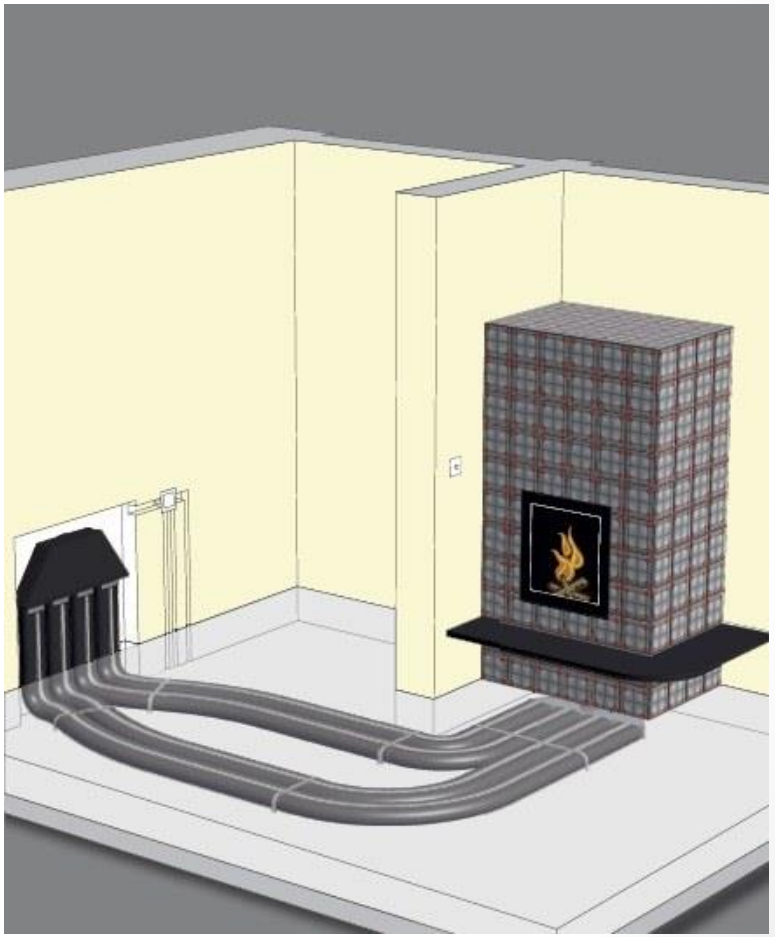
Design solutions

For example, external air supply for combustion can be arranged through channels in the floor



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Design solutions

External air supply
for combustion can be
realized by means of
air chamber, integrated
in chimney flue, air chamber.

Example of execution:

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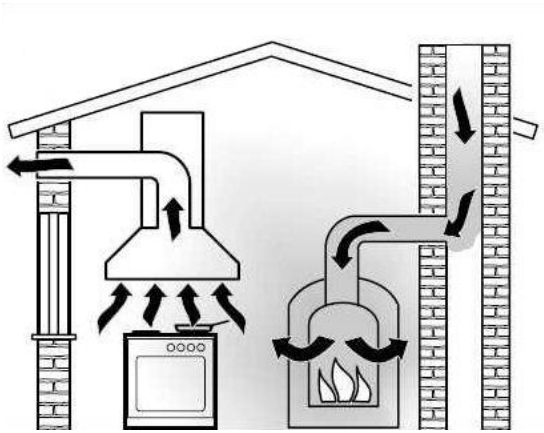
Design solutions - indoor pressure control

Ventilation systems in modern buildings require actions to prevent hazardous pressure conditions.

Hazardous pressure conditions = vacuum in the room.

This creates possibility that combustion products or CO will be drawn from the heat source into the premise.



Source: http://www.augsburger-kaminkehrer.de/

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Design solutions
- indoor pressure control

Possible problems

- Ventilation system works in exhaust mode
- Ventilation system in frost protection mode
- Poor equipment maintenance - air filter is clogged
- Ventilation system malfunction - failure
- Incorrectly designed ventilation system
- Kitchen hood works in hood mode

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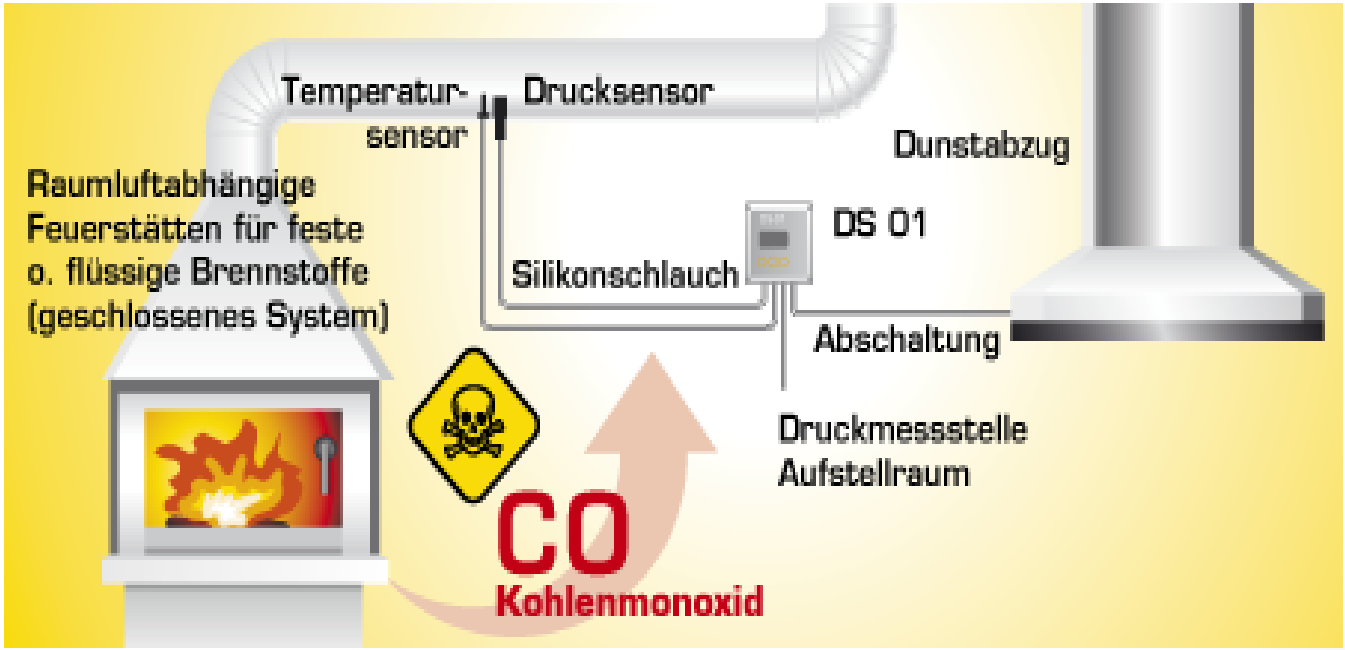
Design solutions
- indoor pressure control

Solution: installation of a pressure switch with a sensor to turn off exhaust ventilation system upon appearance of vacuum in the chimney



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Design solutions

- excess of permissible CO concentration

Further measures:
CO sensor installation

Source: www.rauchmeldershop.at

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Overview of actions required

- Installation of heat sources with low heat output and high accumulation time
- Heat duty calculation
- Loss of tightness in the stove, chimney and adjacent structures shall be minimized → regular maintenance
- External air supply for combustion
- Premise pressure monitoring by means of sensors with possibility of complete shutdown of the exhaust systems in case of vacuum
- CO sensor installation

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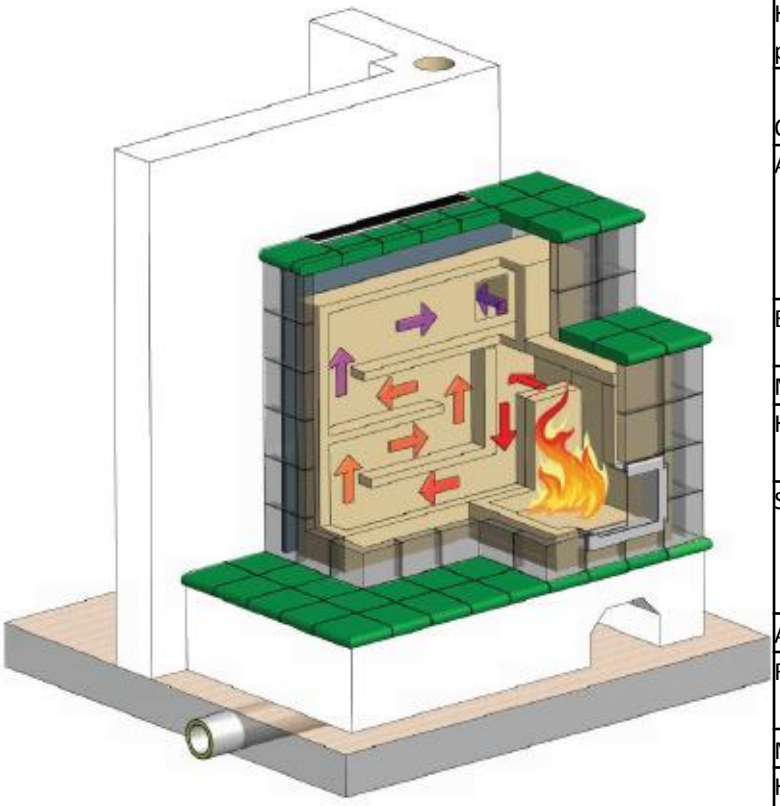
Heat-storing stove



Heat accumulation time (between procedures of fire wood adding)	8-24 h
Quantity of procedures of wood adding	1-3 times per 24 h
Accumulating mass	- not less than 70 kg of accumulating mass per 1 kg of fire-wood - not less than 50 kg of accumulating mass of inner and outer shells per 1 kg of fire-wood
Energy output	1.6 - 11 kW (heat accumulation period - 12 h)
Maximum amount of fire-wood	6 - 40 kg
Heat output method	predominantly uniform soft heat by means of radiation, partly by means of convection
Scope of application	Heating of one or several premises, heating of the whole house, as auxiliary or sole source of heat
Ash removal	3-4 times per heating period
Rate of maintenance	2-5 years, depending on intensity of use, is recommended
Materials	Almost completely ceramic
Hazardous emission	In accordance with EN 15544 or KOV directives

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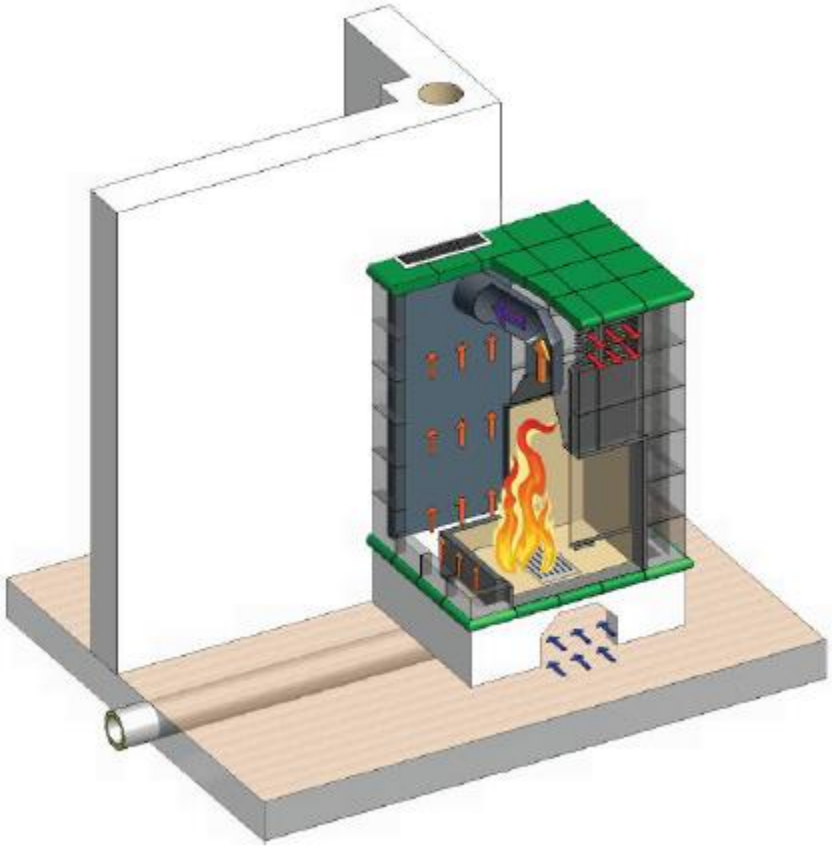
Heating fire-place



Heat accumulation time (between procedures of fire wood adding)	1 - 4 h (depending on construction type)
Quantity of procedures of wood adding	In most cases, 2-3 procedures of wood adding per accumulation period
Accumulating mass	In most cases, 10 kg of accumulating mass per 1 kg of fire-wood
Energy output	9.7 -19.5 kW (with 3 procedures of fire wood adding and heat accumulation period of 4 h)
Maximum amount of fire-wood	4-8 kg
Heat output method	Mainly by convection, to a lesser degree by radiation
Scope of application	Additional source of heat, aesthetic pleasure from fire
Ash removal	Many times per heating period
Rate of maintenance	2-5 years, depending on intensity of use, is recommended
Materials	Observation glass (big door), steel materials, ceramic outer sheeting
Hazardous emission	According to type test

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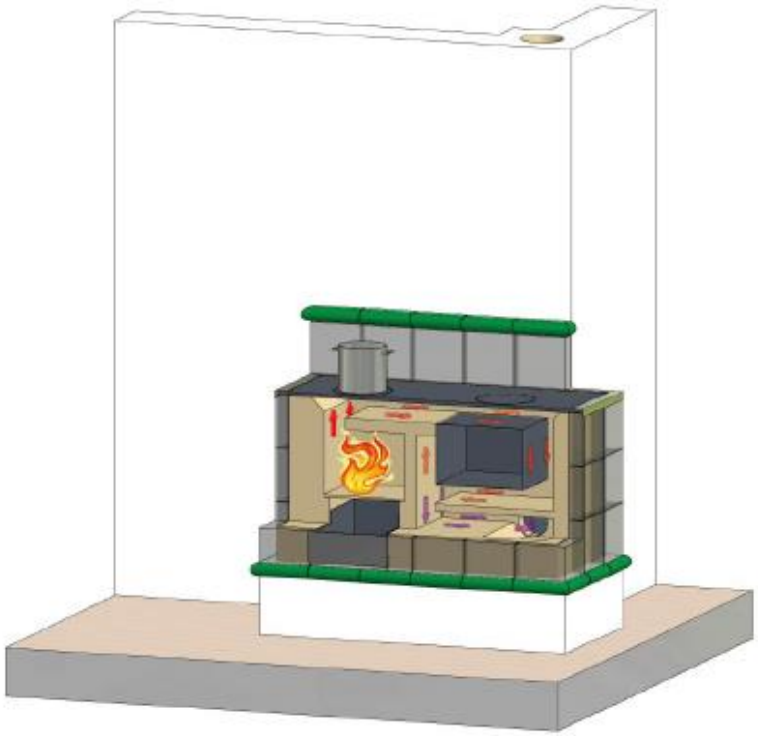
Hearth (heating & cooking stove)



Heat accumulation time (between procedures of fire wood adding)	4 h in most cases
Quantity of procedures of wood adding	Up to 9 times per 24 h (fire-wood is added each 20-30 min)
Accumulating mass	30-50 kg of accumulating mass per 1 kg of fire-wood depending on accumulation time)
Energy output	Up to 2.2 kW (average power per 24 h)
Maximum amount of fire-wood	Generally 1-2 kg
Heat output method	Large amount of convection through the cooking stove and uniform soft heat by radiation through ceramic surface
Scope of application	Cooking (frying, boiling, baking, water heating), heating of one or several premises
Ash removal	Often during heating period
Rate of maintenance	2-5 years, depending on intensity of use, is recommended
Materials	Large number of steel materials (for example, stove, door, oven, water tank) inner and outer ceramic shell
Hazardous emission	In accordance with Austrian Regulatory Documents B 8310

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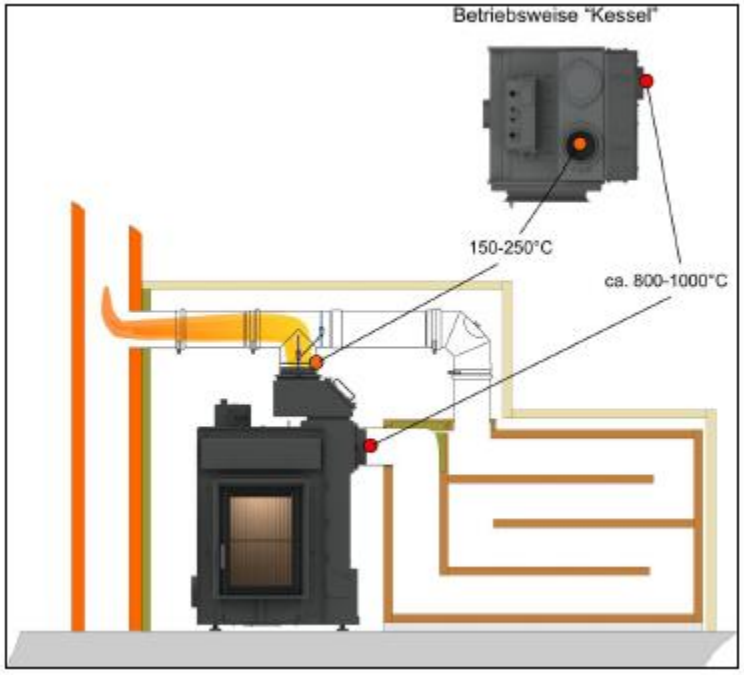
Whole house heating, hypocaust



Heat accumulation time (between procedures of fire wood adding)	8-24 h
Quantity of procedures of wood adding	1-3 times per 24 h
Accumulating mass	Depending on the system applied
Energy output	1.6-11 kW (heat accumulation period - 12 h)
Maximum amount of fire-wood	6-40 kg
Heat output method	Mainly by means of radiation, partly by means of convection
Scope of application	Whole house heating
Ash removal	3-4 times per heating period
Rate of maintenance	Annually (recommended)
Materials	Ceramic materials, steel materials, partly electronics
Hazardous emission	In accordance with EN 15544 or type tests

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Development of VET Training on Energy Efficient Stoves and Fireplaces

INSTALLATION OF PRE-FABRICATED HEAT RELEASE APPLIANCES

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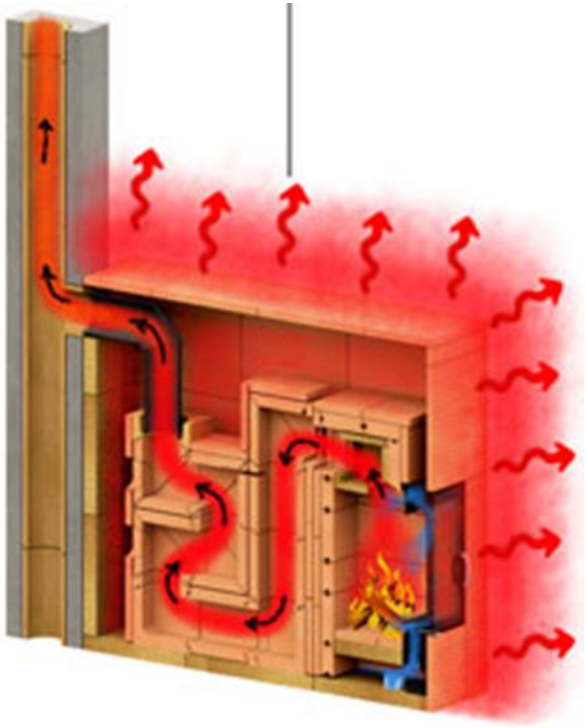
Chamotte stoves (1)



Heat accumulation stoves

Stove chamotte
Weight ≈ 2000 kg

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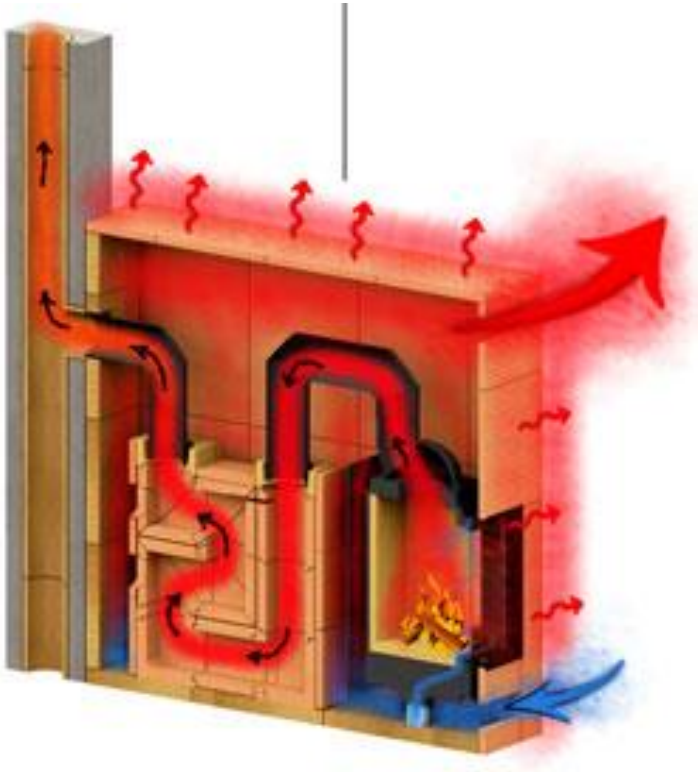
Chamotte stoves (2)



Combined stoves

- Finishing ≈ 200 kg
- External envelope ≈ 300 kg
- Ceramic flues ≈ 500 kg

Stove chamotte
Weight ≈ 1.000 kg

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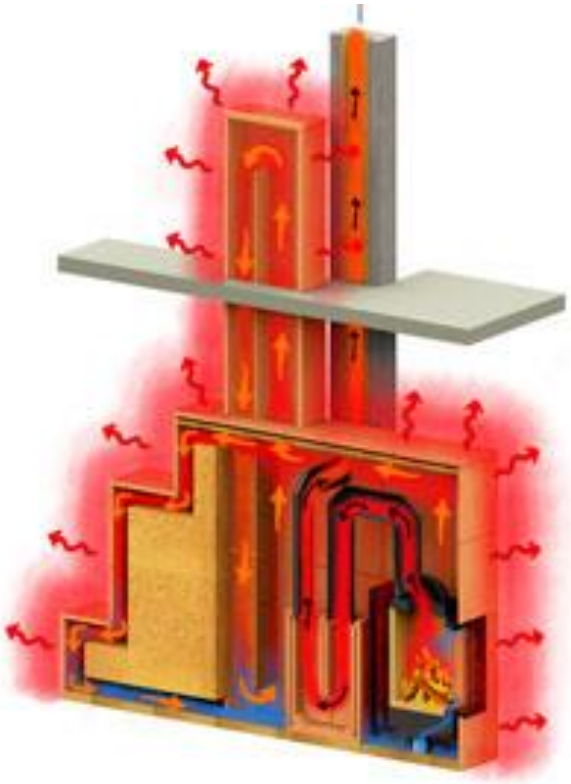
Chamotte stoves (3)



Hypocaust

- External finishing ≈ 200 kg
- External envelope ≈ 300 kg
- Heat radiating surfaces/ air channels ≈ 250 kg

Stove chamotte ≈ 750 kg

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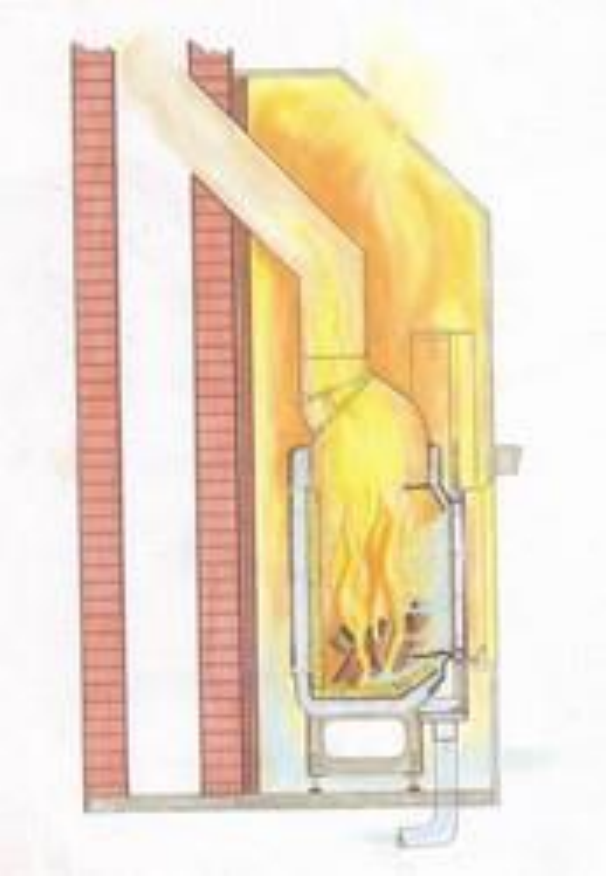
Chamotte stoves (4)



Heating fireplace

- External finishing 200 kg
- External envelope 300 kg

Stove chamotte ≈ 500 kg

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Chamotte stoves (5)

Stove - fireplace

Stove chamotte ≈ 150 kg

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Heat accumulation (1)

How much energy can 2 chamotte bricks accumulate?

Weight of 2 bricks
250x125x65 мм
= 7,3 kg
Thermal conductivity
at 0 - 600°C
= 0,92 kJ/kgK
Heating temperature
= 500 Kelvin

$$Q = m \times c \times \Delta T$$

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Heat accumulation (2)

How much energy can 2 chamotte bricks accumulate?

Weight of 2 bricks 250x125x65 мм
= 7,3 kg
Thermal conductivity at 0 - 600°C
= 0,92 kJ/kgK
Heating temperature
= 500 Kelvin

$Q = m \times c \times \Delta T$

Q = 7,3 kg x 0,92 kJ/kgK x 500 K = **3.358 kJ**

1 kJ = 0.00027777777777778 kWh

3.358 kJ = **0,96 kWh**

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Heat accumulation (3)

How much energy can 2 chamotte bricks accumulate?

Weight of 2 bricks
250x125x65 мм
= 7,3 kg
Thermal conductivity
at 0 - 600°C
= 0,92 kJ/kgK
Heating temperature
= 500 Kelvin

2 chamotte bricks cost 5,74 €

Solar battery of 1 kWh costs 1.500 €

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Heat accumulation (4)

How much energy does a stove accumulate?

Weight = 1.000 kg
Thermal conductivity
at 0 - 600°C = 0,92 kJ/kg•K
Heating temperature
= 150 K

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Advantages of chamotte (1)

- **Durable material**
- **Natural material**
- **Easy to work with**
- **Offers a variety of solutions**

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Advantages of chamotte (2)

Durable material

Resistance to temperature fluctuations ensures durability. The quality and durability of the materials used are very important for the construction of unique and long-lasting individual stoves.

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Advantages of chamotte (3)

Natural material

Burned clay accumulates heat and gives it back to the environment in the most natural way – by radiating, which guarantees optimal heat preservation and consistent release. Made from exceptionally natural products.

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Advantages of chamotte (4)

Easy to work with

Stove chamotte is easy to work with a hammer and ordinary hand tools, mechanical and electric stone cutting equipment. The material is characterized by high mechanical durability. Large panels, special angular and radial elements or pre-fabricated modules can be used to shorten stove installation time.

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Advantages of chamotte (4)

Offers a variety of solutions

Stove chamotte is easy to work with a hammer and ordinary hand tools, mechanical and electric stone cutting equipment. The material is characterized by high mechanical durability. Large panels, special angular and radial elements or pre-fabricated modules can be used to shorten stove installation time.

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VILNIAUS STATYBININKŲ RENGIMO CENTRAS	**VSRC** - Vilnius Builders Training Centre, Lithuania	www.vsrc.lt
KROSNIŲ MEISTRŲ GILDIJA	**KMG** – Association of Lithuanian Stove Builders, Lithuania	www.krosniumeistrugildija.lt
Wolfshöher TONWERKE	**Wolfshöher Tonwerke GmbH & Co. KG,** Germany	www.wolfshoehe.de
KVT Kütte- ja Ventilatsioonisüsteemide Teabekeskus	**KVT** - Centre for Adult Education, Estonia	www.kvtkoolitus.ee
SATAEDU	**SATAEDU** – Satakunta Educational Federation, Finland	www.sataedu.fi

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Development of VET Training on Energy Efficient Stoves and Fireplaces

MASONRY WORK

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MASONRY MORTAR

Mortar is a workable paste used to bind building blocks such as stones, bricks, and concrete masonry units together, fill and seal the irregular gaps between them, and sometimes add decorative colors or patterns in masonry walls.

Mortars are typically made from a mixture of sand, a binder, and water. The most common binder is Portland cement but the ancient binder lime mortar is still used in some new construction. The type of mortar to be used for construction is indicated in the technical drawings.

The name of the mortar depends on the binding material used and can be simple (with one binder) and composite (with two binders).

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PROPERTIES OF MORTAR

Choice of masonry mortar is normally based on several considerations:

- Type of masonry unit and its properties,
- Degree of exposure to weather and environments,
- Strength requirements, etc.

Properties of mortar which are sought for use in masonry are:

- workability,
- water retention,
- rate of stiffening,
- strength,
- resistance to rain penetration,
- durability.

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PROPERTIES OF MORTAR: WORKABILITY

- Workability is the property of mortar which enables it to be spread and applied to masonry unit with ease. It also facilitates proper filling of joints in masonry.
- A good mortar would hang from the trowel and will flow down readily when lightly jerked.
- This property of mortar depends on properties of various ingredients used for making mortar and on the method of mixing adopted.

A mortar prepared from fine clay soil has better workability than one prepared from sandy soil, and a lime mortar has a better workability than cement mortar.

A mortar made from well graded sand has better workability than one made from ungraded sand.

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PROPERTIES OF MORTAR: WATER RETENTION

- It is characterized by the ability of mortar not to stratify during transportation and to retain adequate humidity in a thin layer spread over a porous bed.
- A mortar mix of low water retention will show the defects after hardening. Mortar may lose so much water that the amount left may be insufficient for its hardening and required strength.
- Mineral and organic plasticizing agents may be added to enhance water retention.

Lime mortar and cement-lime mortar have good water retention while plain cement mortar made with coarse ungraded sand has low water retention.

Water retention of masonry mortar should not be less than 70 percent.

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PROPERTIES OF MORTAR: RATE OF STIFFENING

- Stiffening of mortar in masonry is caused either by loss of moisture or by the setting action of binder used in the mortar or by both.

- If rate of stiffening is too low, mortar, due to its plasticity will get compressed and squeezed out, thus resulting in variation in thickness of joints and distortion of masonry.

- if rate of stiffening is too rapid, it will result in cracking masonry as the unavoidable shrinkage in units due to drying and slight settlements in foundation due to loads, cannot then be accommodated within the mortar joints.

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PROPERTIES OF MORTAR: STRENGTH

- A mortar gains strength, to a small extent by loss of moisture that is by drying action, but mainly by setting action of its cementitious content.

- Strength of masonry depends on strength of mortar. **It is however, to be kept in mind that undue importance should not be attached to strength of mortar at the cost of other properties of mortar.**

- Strength of hardened mortar depends on the activity of binding materials, the water-cement ratio, consumption of binding material and the quality of sand.

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PROPERTIES OF MORTAR: RESISTANCE TO RAIN PENETRATION

- Main source of rain penetration is through cracks in masonry which are mostly caused by shrinkage of units and mortar on drying, thermal movement of units and mortar and inevitable slight settlement to which every building is subject.

- Bonding property of mortar is of great importance as it eliminates wide cracks and makes the masonry much more resistant to rain penetration.

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PROPERTIES OF MORTAR: DURABILITY (1)

Deterioration in mortar takes place due to:

- Frost action before the mortar has gained sufficient strength, and repeated cycles of freezing and thawing,
- Prolonged chemical action between soluble sulphates present either in burnt clay bricks or in soil in contact with masonry in foundation,
- Ingress of moisture through cracks into the body of the masonry and consequent repeated cycles of wetting and drying over a number of years and crystallization of salts.

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PROPERTIES OF MORTAR: DURABILITY (2)

- For protection against frost damage, and repeated cycles of freezing and thawing, it is necessary that mortar should gain strength rapidly, it should be dense and should have good ultimate strength. lt should therefore, contain adequate proportion of portland cement, and sand should be well graded.

- For protection against sulphate attack, a rich cement mortar or composite cement-lime mortar should be used when only moderate protection is needed and rich cement mortar with sulphate resisting cement should be provided when sulphate attack is expected to be severe.

- To ensure durability of mortar against weathering action due to repeated cycles of wetting and drying of masonry (for example, parapets) in exposed situations, mortar should be dense and moderately strong.

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TYPES OF MASONRY: STONE MASONRY

- **Rubble masonry** is rough, unhewn building stone set in mortar, but not laid in regular courses. It may appear as the outer surface of a wall or may fill the core of a wall which is faced with unit masonry such as brick or cut stone.

- **Ashlar masonry** is stone masonry using dressed (cut) stones.

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TYPES OF MASONRY: BRICK MASONRY

- **Calcium Silicate (Sand Lime) bricks** are used to build outer and inner walls, pillars and other structures. Their masonry is strong, keeps heavy loads.

- **Ceramic hollow bricks** are used for building inner walls and partitions.

- **Fire (Refractory)** bricks are typically used for lining the inside of a furnace, fireplace, stove, chimney, etc., and serve as great insulators, making heat loss minimal and energy use efficient.

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MASONRY MATERIALS

Silicate blocks

- Environmentally friendly, resistant to compression, cold, and fire, soundproof, highly resistant to water absorption, easy to process, feature precise dimensions;
- Used for building external and internal walls (bearing and non-bearing) of public and industrial buildings, residential houses.
- The special shape of the blocks allows to construct the wall without vertical joints, using thin-layer mortar or glue for horizontal joints.
- Main advantages if compared to bricks - reduced building costs and shorter construction time.

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MASONRY MATERIALS

Concrete blocks

- Made of gravel, sand, cement, water.
- Used for building walls of multi-storey residential, industrial buildings; walls between apartments and flights; exterior load-bearing walls of residential buildings; basements of low-rise buildings; partitions; ventilation openings, etc.
- Main advantages
  - Precise geometric dimensions;
  - Resistant to compression;
  - Sound-proof;
  - Optimal water absorbtion;
  - Due to precise dimensions and a smooth surface, the cost of finishing is reduced.

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MASONRY MATERIALS

Ceramic concrete blocks

- Made from clay granules fired in high temperature, cement and water.
- Used for building external bearing walls of low-rise buildings; partitions; basements of low-rise buildings; partitions; chimneys and ventilation openings, etc.
- Main advantages
  - Precise dimensions;
  - Solid and light;
  - Resistant to fire, cold, water and chemical substances;
  - Ecological;
  - Sound-proof;
  - Easy to work with and apply finishing.

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MASONRY TOOLS AND EQUIPMENT

Depending on the masonry materials used and the work being done, the tools are divided into:

- main work tools;
- control measuring tools and instruments;
- block masonry tools;
- finishing and decorative masonry tools;
- masonry demolition tools;
- auxiliary bricklayer equipment.

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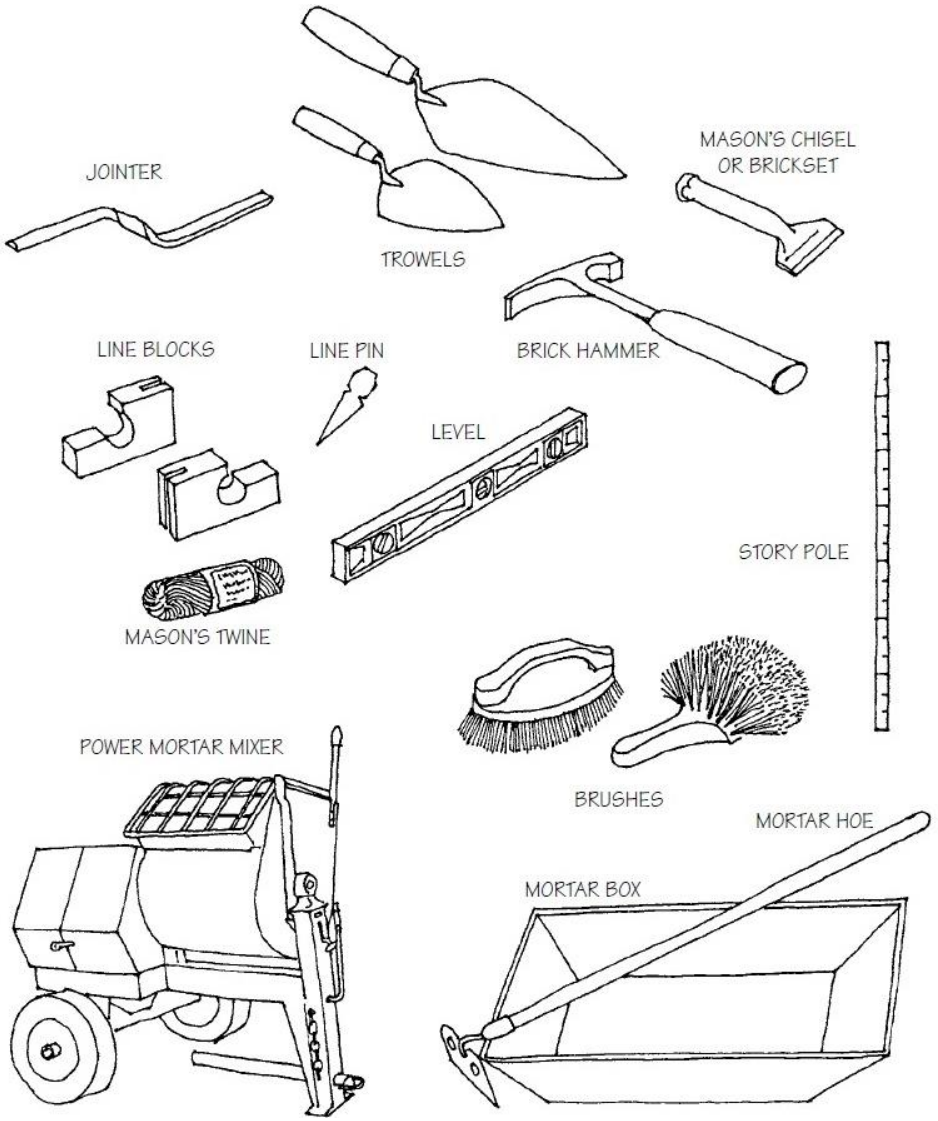
MASONRY TOOLS



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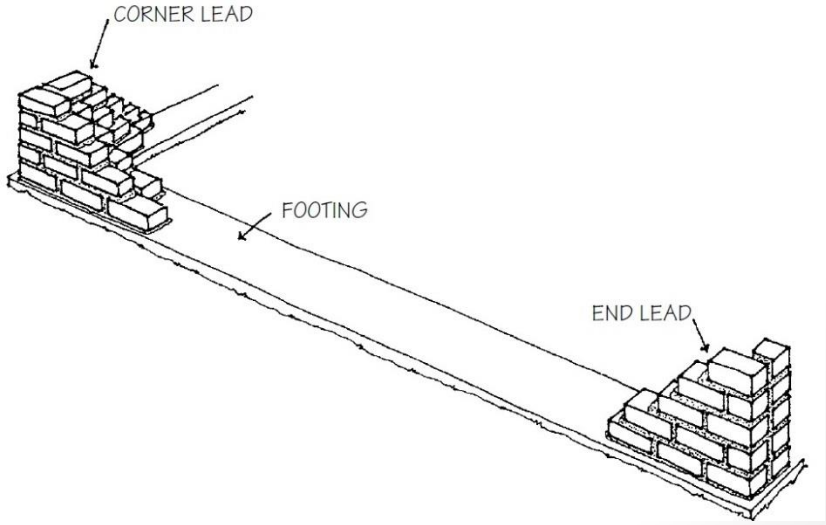
MASONRY CONSTRUCTION

- Masonry construction consists of the placement of brick or block and mortar and the installation of accessory items such as anchors, ties, reinforcement, flashing, and weeps.
- One of the most important elements of masonry construction is keeping the wall straight, level, and plumb and accurately maintaining the horizontal and vertical coursing.
- Vertical coursing can be established by building leading sections or leads at the ends or corners of walls.



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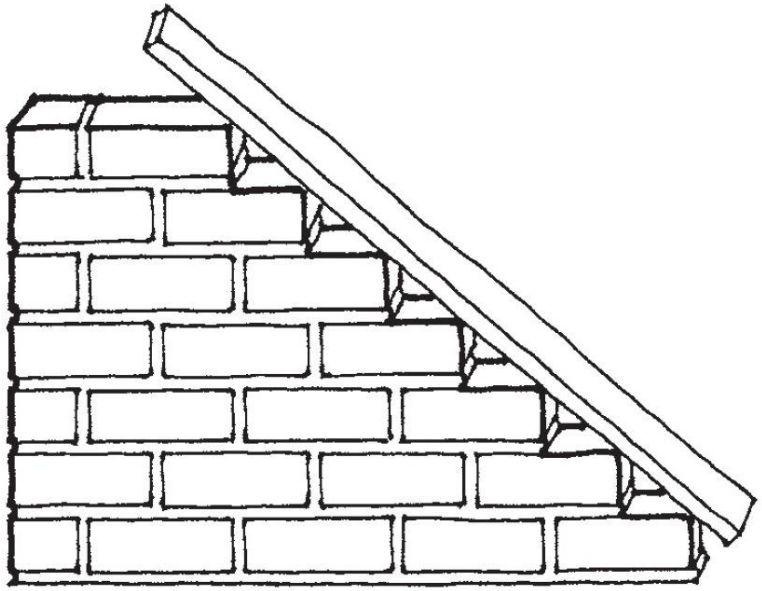
MASONRY CONSTRUCTION

The first course of a lead should be at least four or five units long and carefully aligned so the wall will be straight and not bowed or curved. Corners must be laid at true right angles of exactly 90 degrees. The second and successive courses of the lead are racked back one-half unit length in each course to establish a typical running bond pattern in which one unit overlaps the unit in the course below by half its length.



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ENEFFIS

Development of VET Training on Energy Efficient Stoves and Fireplaces

No 2016-1-LT01-KA202-023161

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Development of VET Training on Energy Efficient Stoves and Fireplaces

MODERN HEAT SOURCES

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Energy efficient heat sources

- Norms and regulations:

EN 15250:2005
Slow heat release appliances fired by solid fuel: Requirements and test methods

EN 12815:2005
Residential cookers fired by solid fuel: Requirements and test methods

EH 15544:2009
Individually made heat accumulation tiled and plastered stoves

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Energy efficient heat sources

- Norms and regulations:

EN 13229:2005
Residential cookers fired by solid fuel: Requirements and test methods

EN 13240:2005
Roomheaters fired by solid fuel: Requirements and test methods

TR OL 2006
Technical regulations for design, determination of dimensions, installation of convectional, tiled and plastered stoves, heat sources for heating two-storey building, heating with heated surfaces, hypocaust, heat accumulation stoves, open fireplaces, closed fireplaces, hearths, bakery ovens

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Energy efficient heat sources

- Construction types of heating sources

Construction type	heavy type	intermediate type	light type	Permission
Stove wall thickness	13 cm	11 cm	10 cm	+/-1 cm
First duct wall thickness	12.5 cm	10.5 cm	8.5 cm	+/-1 cm
Last duct wall thickness	5 - 10 cm	5 - 8 cm	5 - 6 cm	
Specific heat flow	0.5 kW/m²	0.75 kW/m²	0.9 kW/m²	+/- 10 %
External surface temperature (difference with room temperature)	40 K	55 K	65 K	+/- 5 K
Weight per 1 kW ~	250 kg	170 kg	130 kg	

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Energy efficient heat sources

- **Heat-retaining stoves**

Heat-retaining stoves – stationary hearth stoves

The hearth and ceramic ducts are made by hand at the place of installation
The hearth has individual size
or "proven hearth"

Transfer of heat to the premises is carried out mainly by radiation

- Long-term accumulation of heat
- For solid fuel only
- High efficiency, ≥ 70%
- Low level of hazardous emission
- Heavy weight ≈ 2000 kg
- Construction type: heavy type

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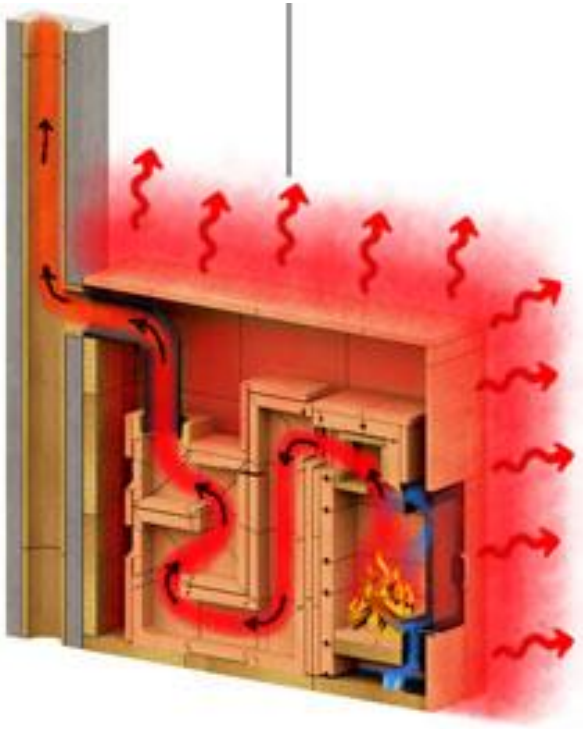
Energy efficient heat sources

- **Heat-retaining stoves:** structural parts



Hearth limiter (stove doors)
single door, consists of stove door (partially hearth door)
double door, consists of stove door and ash removal door,
triple door, consists of stove door, ash removal and loading door

Masonry hearth
- custom made
- proven hearth

Ceramic combustion product ducts
Heat-storing shell
- made of stove chamotte;
- stove tiles;
- natural stone;
- combined solutions

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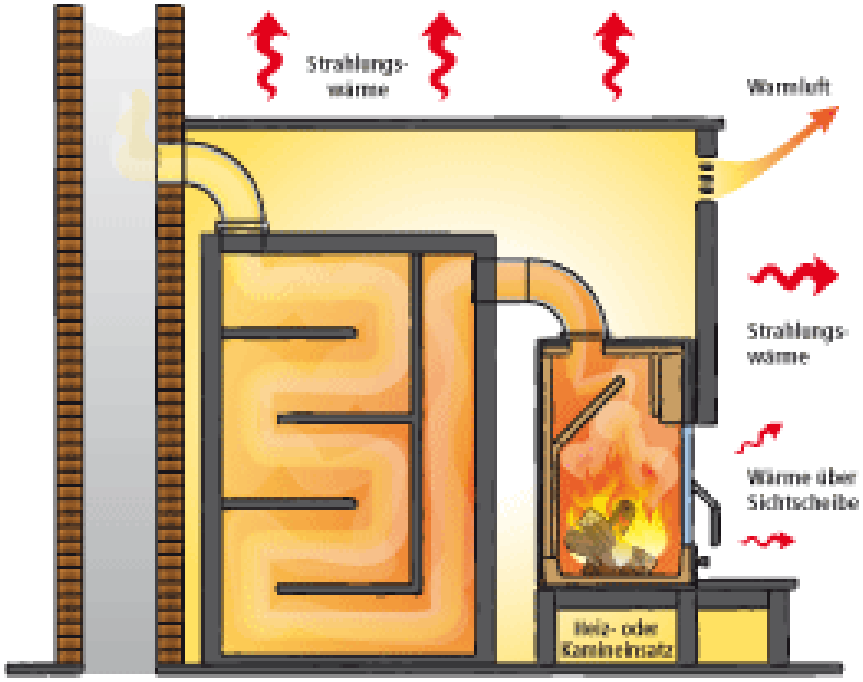
Energy efficient heat sources

- **Convection stoves with ceramic channels** – accumulating stoves / combined stoves



Speicherofen: Heizeinsatz mit keram. Nachheizfl.

Stove hearth (acc. to EN 13229) with ceramic channels of combustion products
Heat transfer to the premises mainly by means of convection
Heat accumulation depends on mass and construction type.

Ceramic ducts for combustion products are made individually of stove chamotte:
- of plates and stones
- of figurate stones
- of modular stones

Construction type: light, average and heavy

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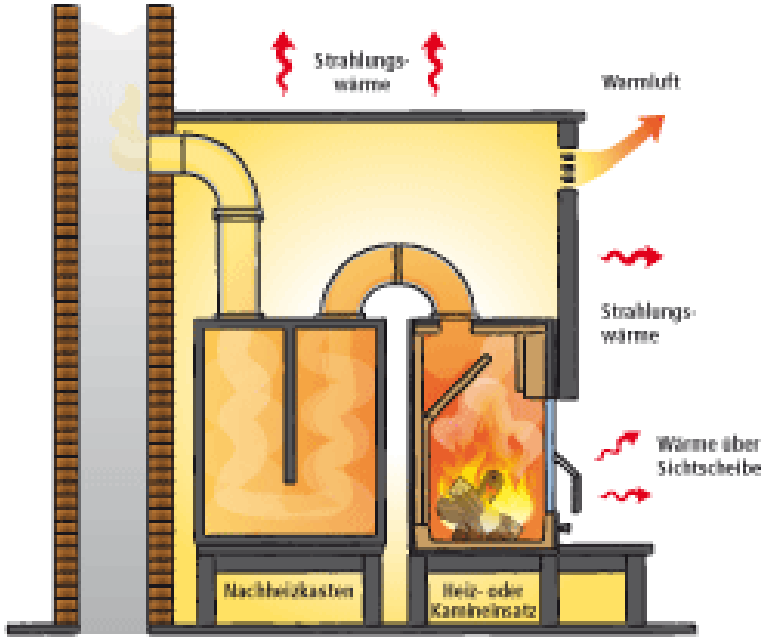
Energy efficient heat sources

➢ Convection stoves



Warmluftofen: Heizeinsatz mit Nachheizfläche

Stove hearth according to EN 13229
with steel ducts for combustion products

Transfer of heat to the premises is carried out mainly by convection

Heat-storing chamber consists of:
- the shell,
- the slab,
- floor (place of installation of stove hearth and ducts);
- adjacent walls (with heat insulation)
- combustion product ducts made of sheet steel (thickness of 2 mm) or cast iron (checked/approved for use with stove hearth)

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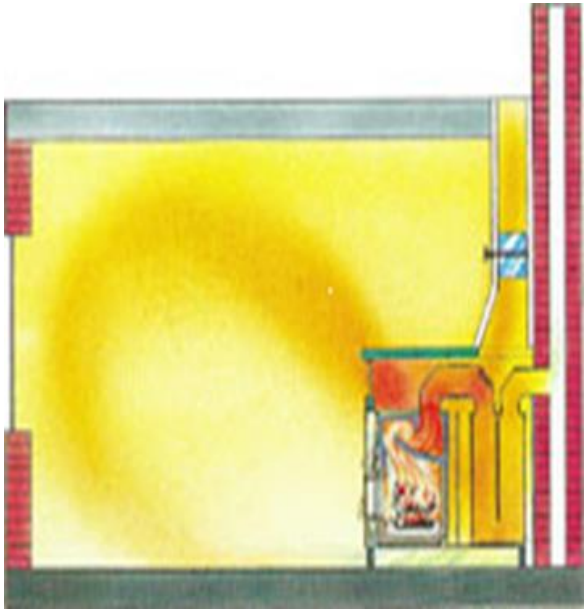
Energy efficient heat sources

- **Convection stoves** to heat entire residential building



Stove hearth acc. to EN 13229

Ducts for transportation of combustion products

made of ceramics and steel

Heat transfer distribution

Most of heat is transferred by convection (air grates, holes for inlet and circulating air)

Minor part of heat is transferred to the premises by radiation from front surface and active external surfaces

The stove can also be installed in the basement and have well-insulated heat-storage chamber.

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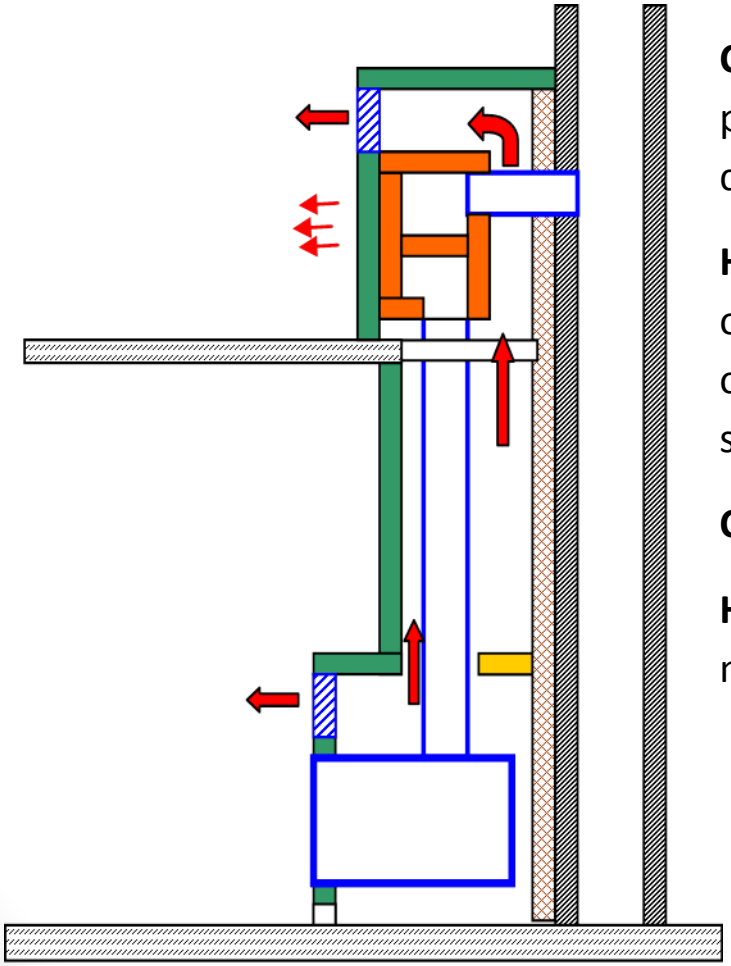
Energy efficient heat sources

- **Convection stoves** to heat two storeys



Ceramic ducts for transportation of combustion products are located on the upper storey and are connected with heating source by vertical pipe 1.

Heat-storing chamber can go through the flooring of the upper storey, or, conversely, can be located on the storey, which is located lower than the storey with stove heather.

Chimney connection is located on the top storey.

Heat transfer to the furnace is carried out by means of convection and radiation.

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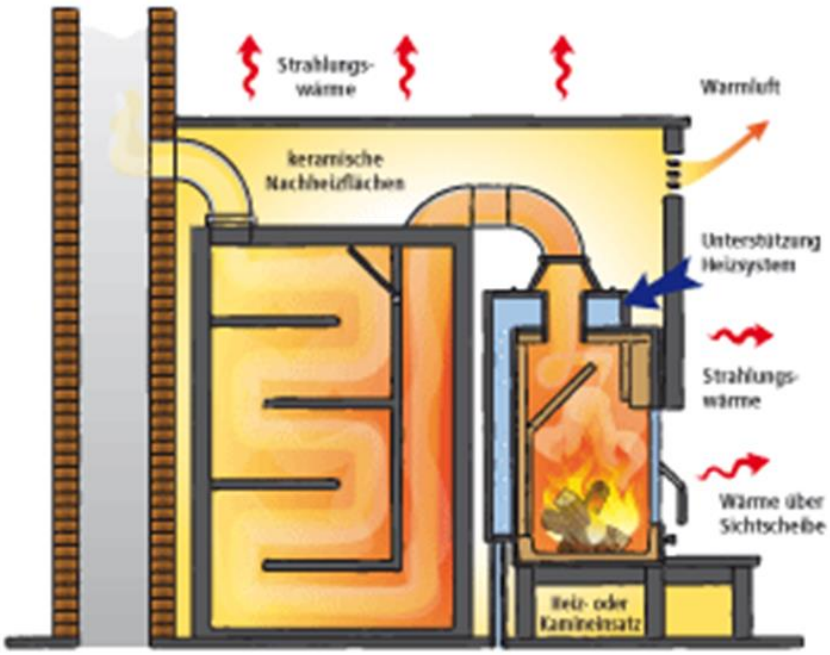
Energy efficient heat sources

- **Convection stoves** with water circuit



Speicherofen: Heizeinsatz mit Wassertechnik

Stove hearth acc. to EN 13229 operating like a boiler

Connection of water circuit for heating of water in the building's heating system to expansion tank.

Depending on the manufacturer’s recommendations, the furnace has ceramic or metal ducts of combustion products

Heat-storing chamber of stove chamotte, natural stone, stove tile

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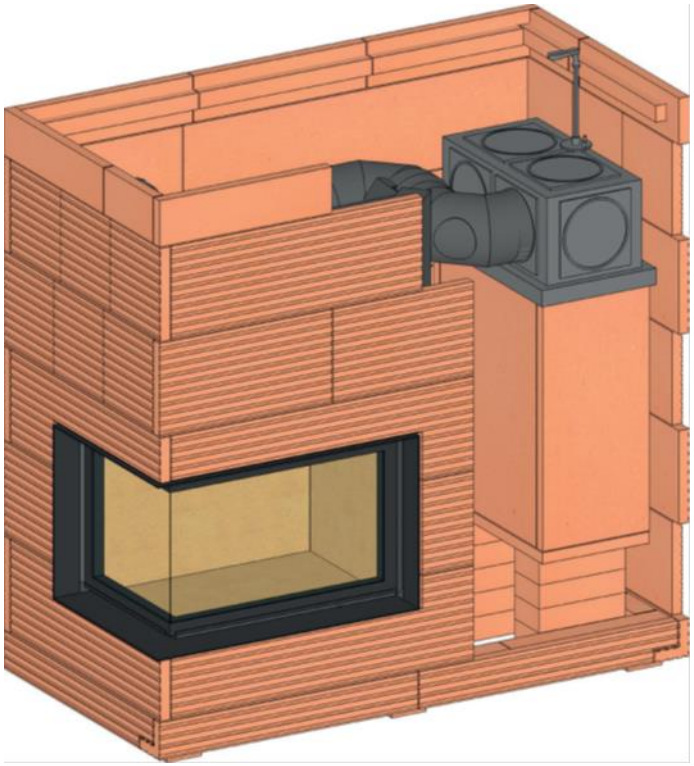
Energy efficient heat sources

- **Combined stoves:** convection heat-storing stoves with ceramic ducts



Stove hearths acc. to 13229
Ceramic ducts for combustion products

Transfer of heat to the premises is carried out mainly by convection

Custom ceramic ducts made of stove chamotte:

- of plates and stones

- of figurate stones

- of modular stones

Heat-storing chamber made of stove chamotte:

- for solid fuel only

- High efficiency, ≥ 70%

- low level of hazardous emission

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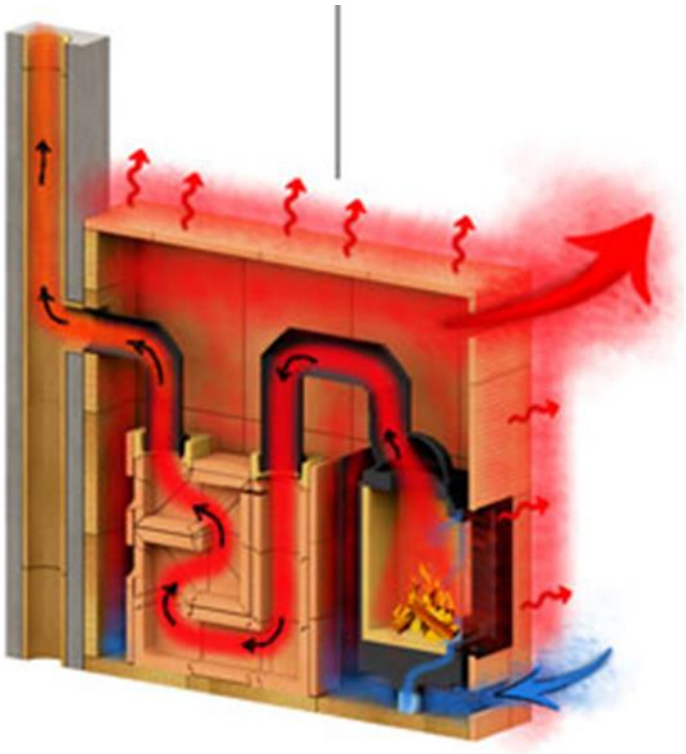
Energy efficient heat sources

- **Combined stoves:** convection heat-storing stoves with ceramic ducts



Heat-storing ability
depends on mass and construction type.
Such stoves can be of light, intermediate and heavy type

Stove hearth ≈ 190-300 kg
ceramic ducts ≈ 200-500 kg,
outer shell ≈ 300 kg,
stove tiles
or natural stone ≈ 200 kg

Total weight ≈ 900-1500 kg

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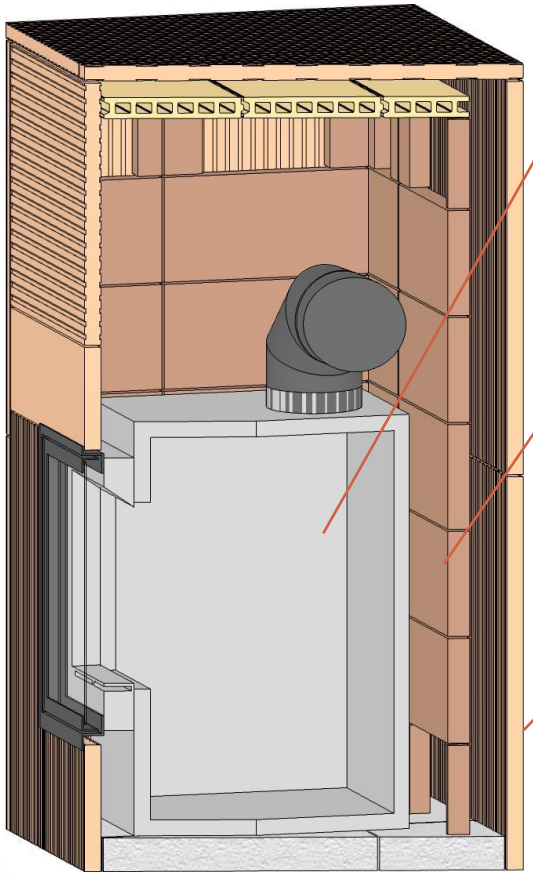
Energy efficient heat sources

Hypocaust: closed type air heating system



Heat sources with stove or fireplace hearth acc. to EN 13229. Hearths shall be approved for use in hypocaust system! It is necessary to pay attention to manufacturer's recommendations.

Heat-storing unit made of heavy grade stove chamotte:
HSM, density - 2.4 t/m³
HSM, density - 2.9 t/m³
Faust's rule: 60-80 kg of heat-storing mass are required per 1 kg of fire wood.

Outer shell of classic grade stove chamotte in thickness of 30-40 mm.
Total weight of stove chamotte ≈ 750-1000 kg,
Designs with the stove ≈ 1000-1250 kg.

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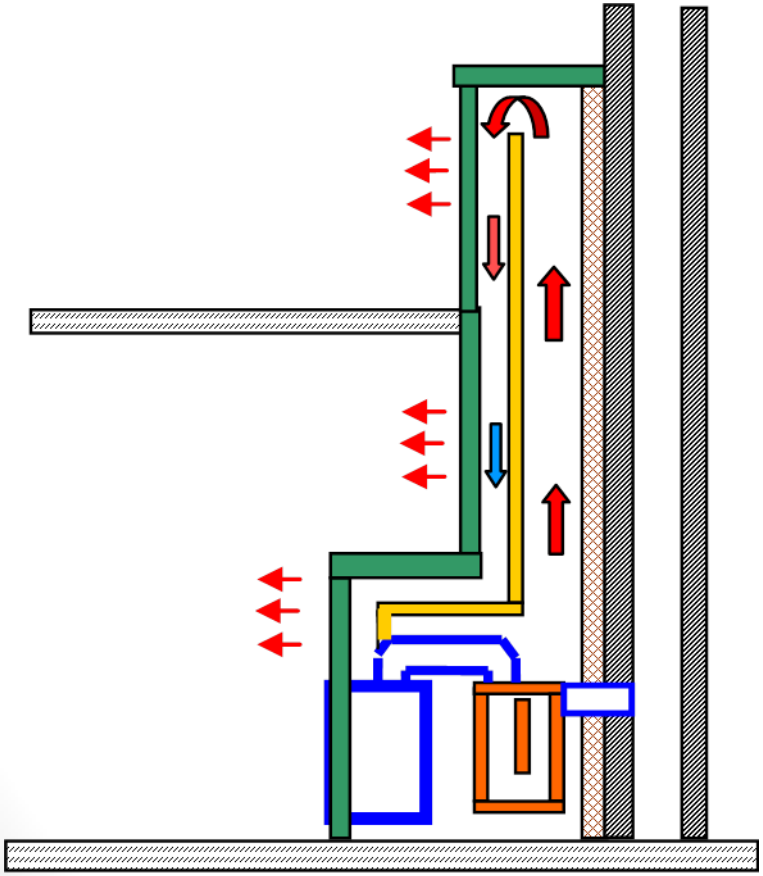
Energy efficient heat sources

Hypocaust: closed type air heating system



Hot air circulates inside and does not go outside the structure.

Hypocaust can be built to heat two floors.

Heat transfer is carried out mainly by means of radiation from external surface, respectively, from external surfaces of the hearth and combustion product ducts.

Connection of the chimney is carried out in the same premises where the hearth is installed

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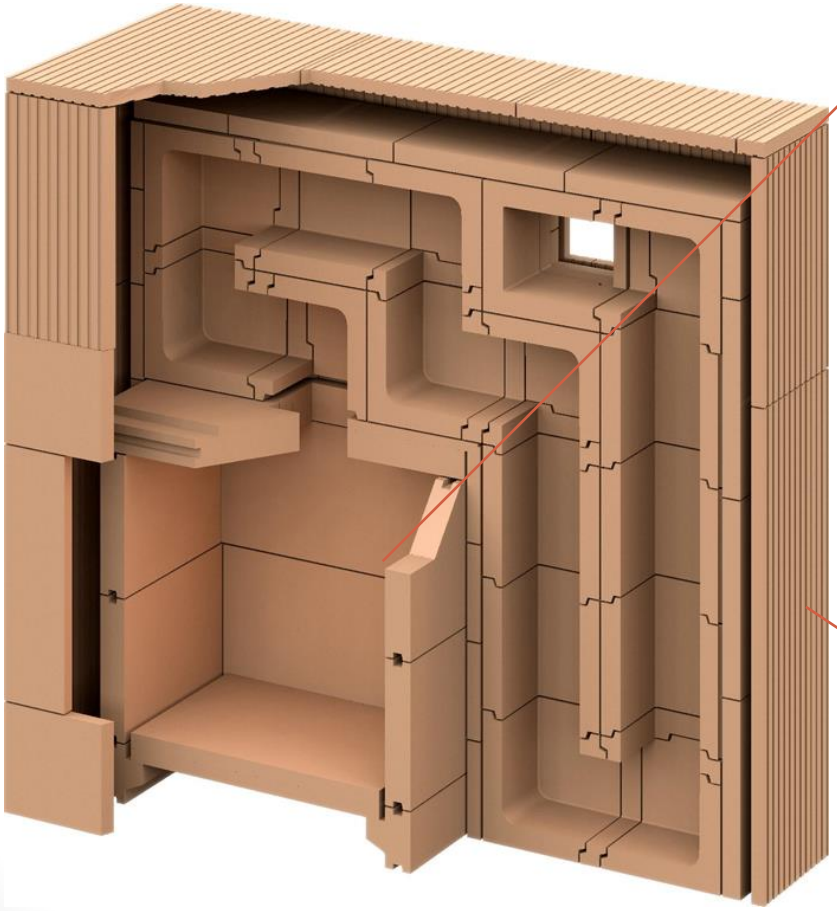
Energy efficient heat sources

Heat-storing fire-place



Custom hand-built hearth made of stove chamotte with thickness of 60-89 mm

Large slabs provide fewer seams and save installation time

Stove door with large glass shall be released for service in construction of heat-storing fire-place

Outer shell of stove chamotte in thickness of 30-40 mm. Efficiency factor ≥ 70%

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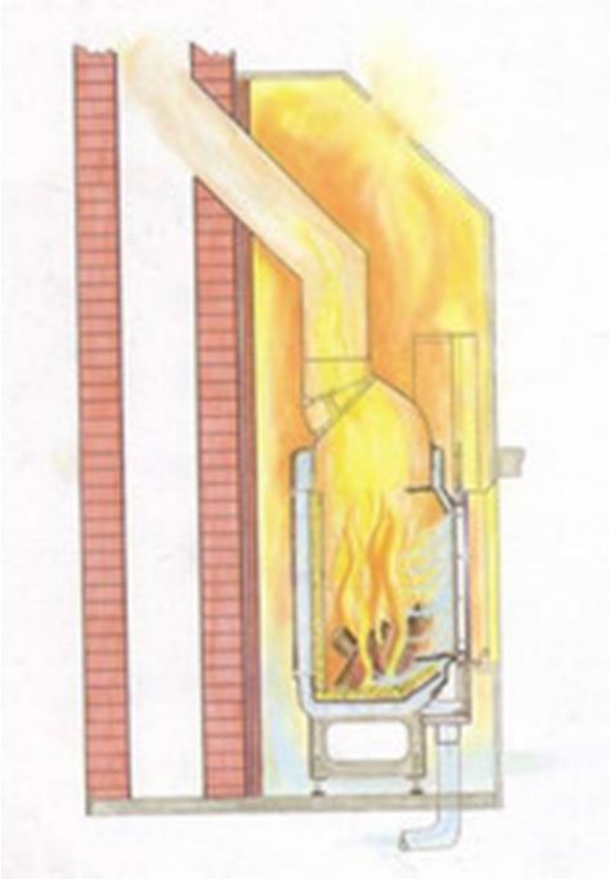
Energy efficient heat sources

Closed-type and open-type fire-places: heating fire-place



Fire place hearth, prefabricated acc. to EN 13229, with convection duct or heat-storage chamber.

Shall be used with closed door only!
Heat transfer by radiation from glass surface and external duct surface or heat-storage chamber

Convection - through the duct holes.

Use of ceramic or steel combustion product ducts is possible only on recommendation of the hearth's manufacturer

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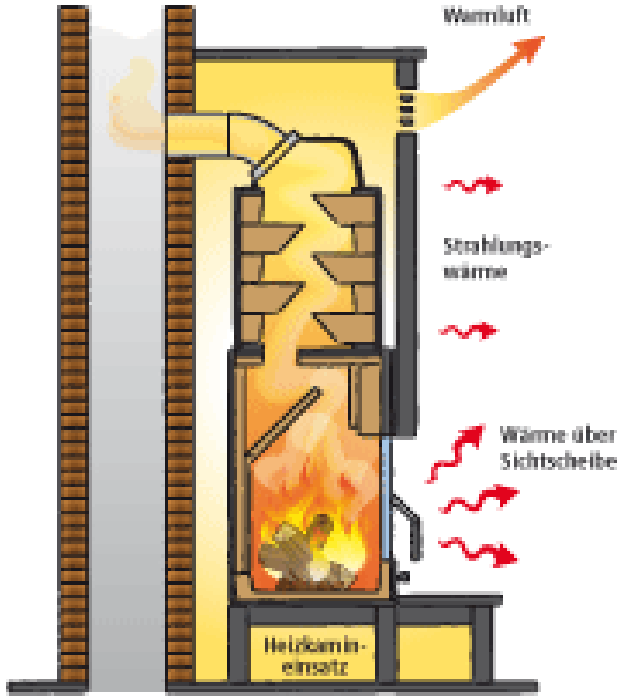
Energy efficient heat sources

Closed-type and open-type fire-places: heating fire-place



Heizkamin mit Speicheraufsatz

Fire-place hearth prefabricated according to EN 13229

Heating fire-place with heat accumulating nozzles (plates or rings), providing additional heat-storage

Shall be used with closed door only!

Heat transfer by radiation from glass surface and external duct surface or heat-storage chamber **by convection** through the holes in convection shell or heat-storage chamber

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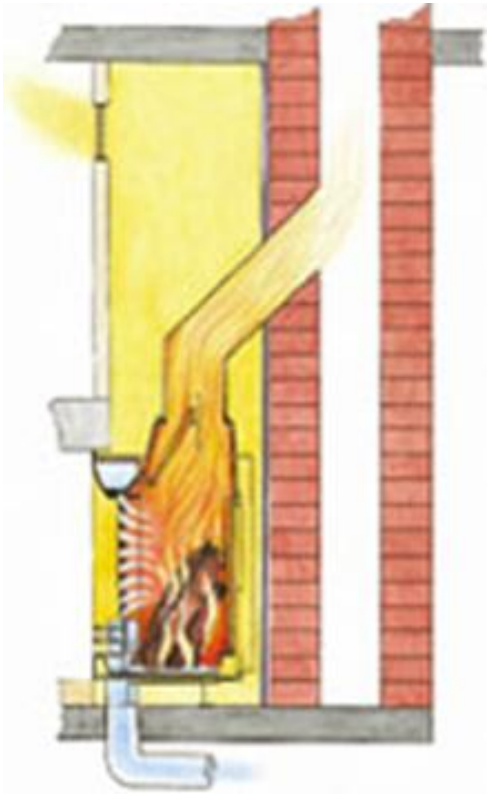
Energy efficient heat sources

Closed-type and open-type fire-places:
Open-type fireplace, construction type A



Fire-place hearth or
fire-place cartridge acc to EN 13229

Can be equipped with door or be without it.

Can be operated with open or closed door.

Suitable for prescribed mode of operation only!

It is necessary to pay attention to manufacturer's instructions.

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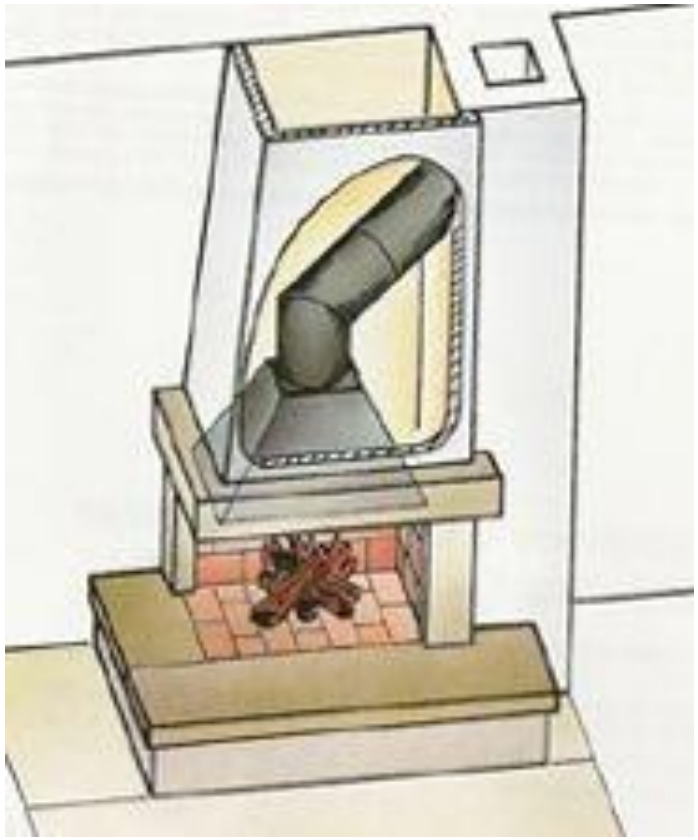
Energy efficient heat sources

Closed-type and open-type fire-places:
Open-type fireplace, construction type B



Custom hand-built open fireplace without prefabricated hearth

Open fire

Can be used in permitted cases only, taking into account release for service

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Energy efficient heat sources

Heat sources for heating of a single premise

Heat sources acc. to EN 13240, which heat only those premises, in which they are installed.

Additional heat accumulation is possible due to finishing by stove tiles

Can be equipped with water circuit,

Movement to another place and installation in new house is allowed.

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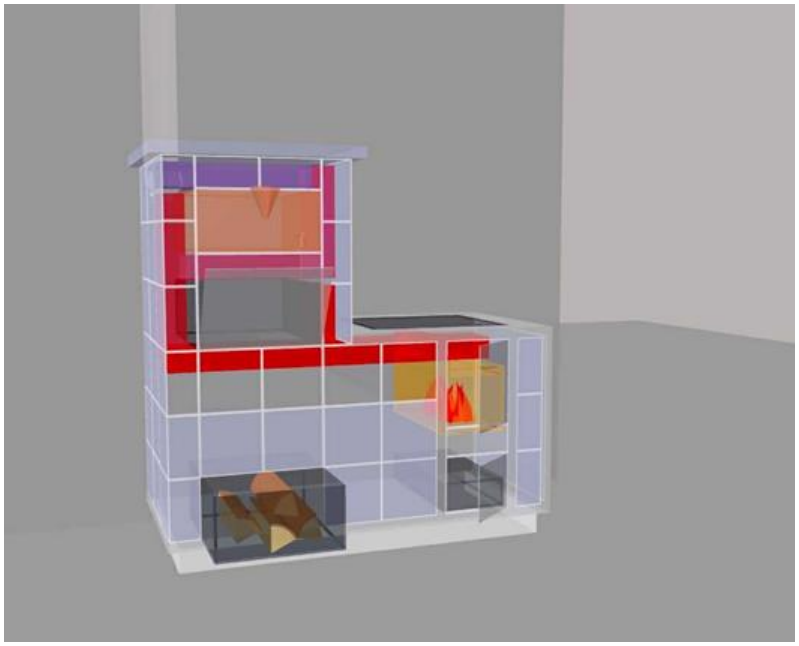
Energy efficient heat sources

Heating & cooking stoves



Design is in acc. with EN 12815:2005

Applies to solid-fuel household heating and cooking stoves with manual fuel loading, main function of which is cooking and heating the room in which the stove is installed.

These stoves can produce hot water for household needs and/or hot air for air heating systems.

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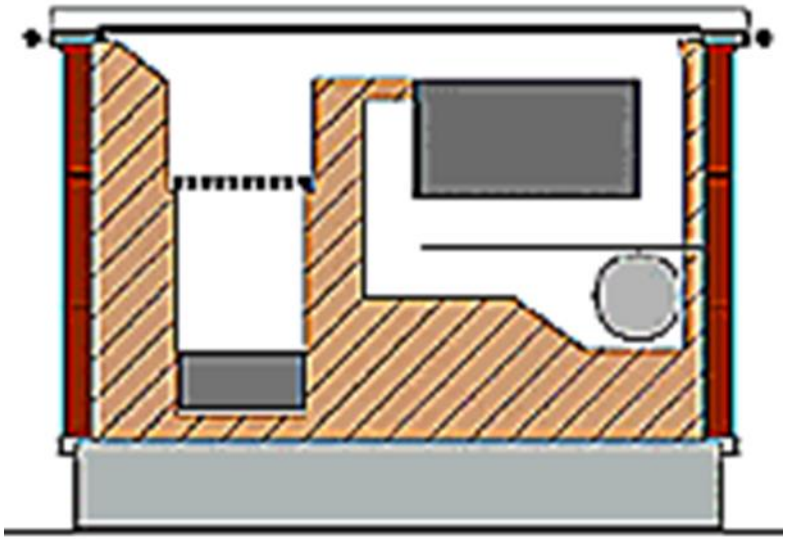
Energy efficient heat sources

Heating & cooking stoves: tile stove-table



Custom hand-built stove with stove tiles, pot stone, brick work or masonry work, stove chamotte plates with plastered outer surface

Cooking stove made of steel or cast iron

Embedded elements: oven, water circuit, niche for heating of food or dishes

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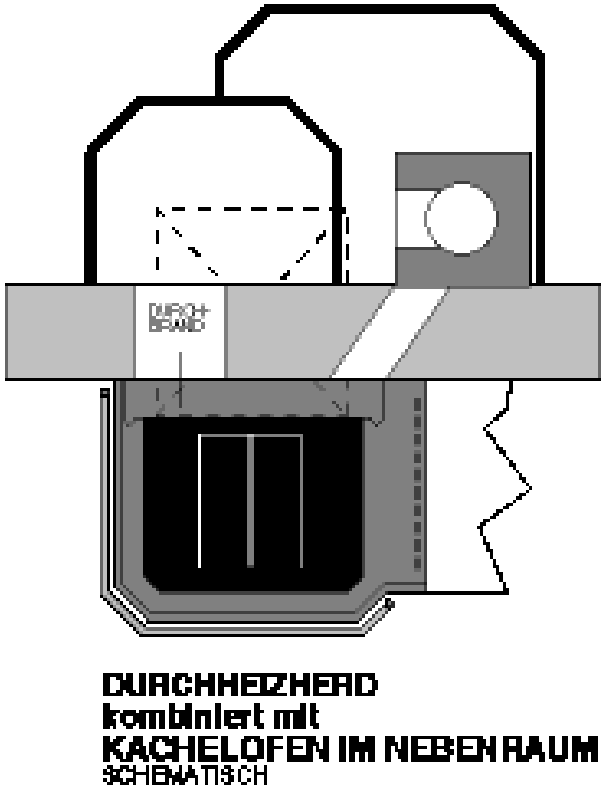
Energy efficient heat sources

Heating & cooking stoves:
Tiled stove with integrated smoke flue ducts



Custom hand-built stove with stove tiles, pot stone, brick work or masonry work, stove chamotte plates with plastered outer surface

Heating of ceramic combustion product ducts in the next room (warm wall).

Summer / winter mode is used in case of large surface area of warm wall.

Can be combined with prefabricated heating & cooking stove (stove-table)

Heating & cooking stoves:

Tile stove with additional top elements

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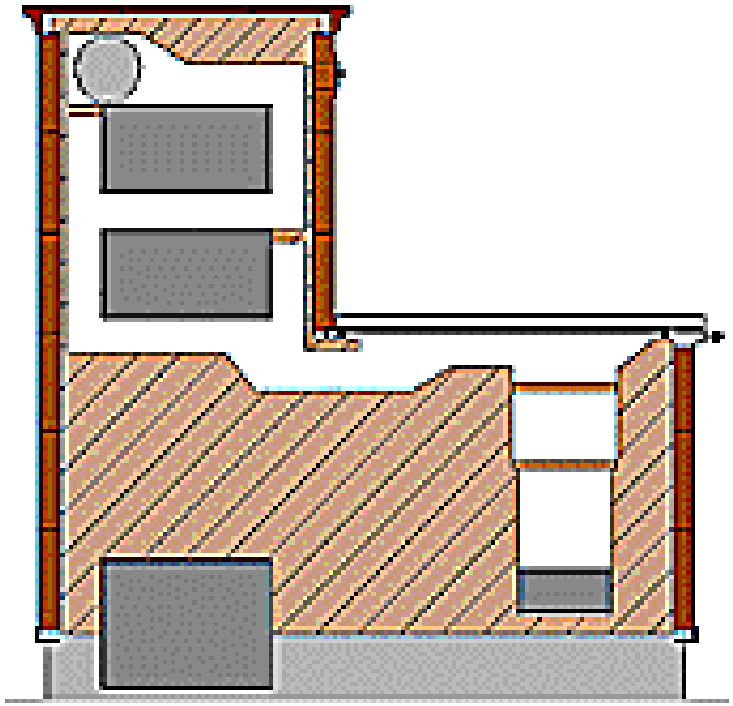
Energy efficient heat sources

Heating & cooking stoves:
Tiled stove with embedded elements



Custom hand-built stove with stove tiles, pot stone, brick work or masonry work, stove chamotte plates with plastered outer surface

Summer / winter mode is used in case of large surface area of the stove.

Embedded elements:

Steel ovens

Water heating tanks

Niche for heating of dishes or food, niche for herbs, hops, malt drying

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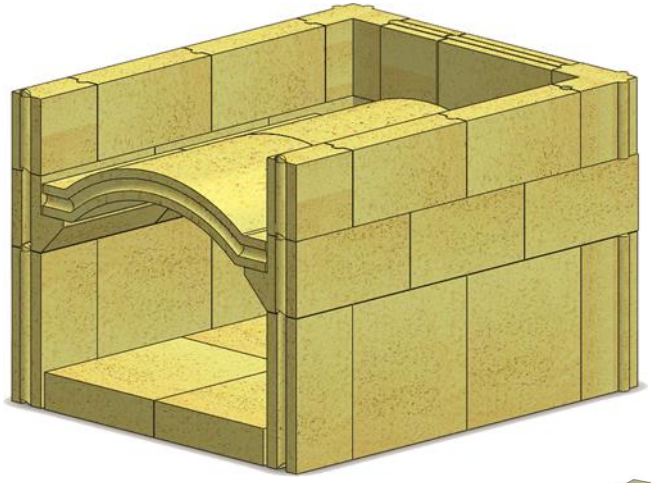
Energy efficient heat sources

- **Baking ovens**

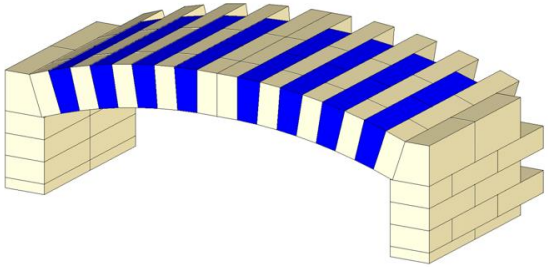


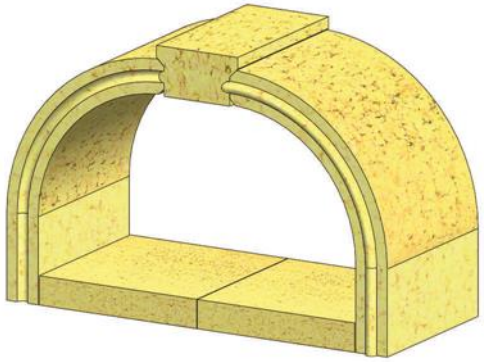
Baking ovens are hand-built

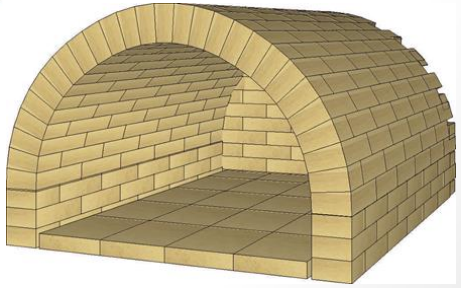
using prefabricated plates and stones

Direct heating; after heating, coal is removed from the hearth

Baking oven = hearth







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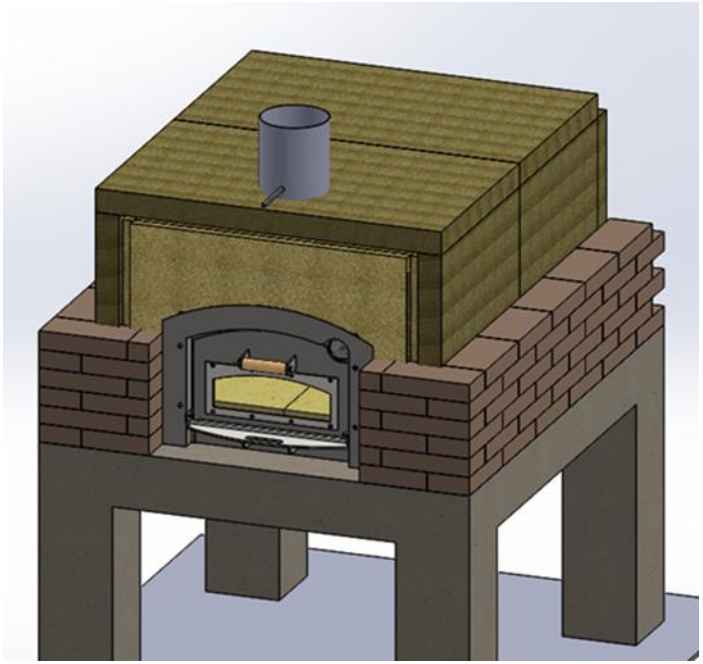
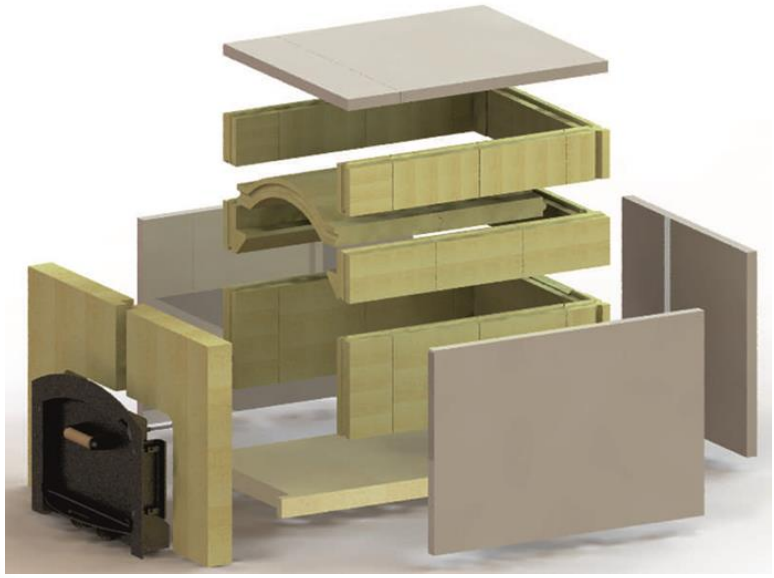
Energy efficient heat sources

- **Baking ovens**

The baking oven consists of the pedestal, the baking oven, sometimes with additional hearth, the small duct for combustion products, insulation, facing, a chimney, and (sometimes) a roof.





Stoves can be heated by gas, fire wood, electricity.

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Development of VET Training on Energy Efficient Stoves and Fireplaces

No 2016-1-LT01-KA202-023161

VILNIAUS STATYBININKŲ RENGIMO CENTRAS	**VSRC** - Vilnius Builders Training Centre, Lithuania	www.vsrc.lt
KROSNIŲ MEISTRŲ GILDIJA	**KMG** – Association of Lithuanian Stove Builders, Lithuania	www.krosniumeistrugildija.lt
Wolfshöher TONWERKE	**Wolfshöher Tonwerke GmbH & Co. KG,** Germany	www.wolfshoehe.de
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Development of VET Training on Energy Efficient Stoves and Fireplaces

Preparatory work

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WORK SAFETY REQUIREMENTS

Work safety, environmental protection, fire safety requirements

The leading safety hazards on construction sites include falls, being caught between objects, electrocutions, and being struck by objects.

Failures in hazard identification are often due to limited or improper training and supervision of workers.

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EDUCATION AND SAFETY

Construction workers need to be properly trained and educated on the task or job before working, which will assist in preventing injuries and deaths.

There are many methods of training construction workers. One method is coaching construction site foremen to include safety in their daily verbal exchanges with workers to reduce work-related accidents.

It is important that the workers use the same language to assure the best communication. In recent years, apart from traditional face to face safety knowledge sharing, mobile apps also make knowledge sharing possible

The project H&S games is designed to address the acquisition of basic health and safety skills through innovative methods, as serious game is. It will develop, test and implement an online training tool regarding basic Health and Safety matters for a building site.

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WORKSAFETY AT SITE

- Describe personal protective equipment, health and safety, environmental protection and fire safety requirements.

- Describe principles of sustainable construction.

Store materials and equipment necessary for building and installation of a solid fuel heat release appliance in accordance with the manufacturer's requirements and without compromising their quality

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PREPARATION OF WORK PLACE FOR STOVE BUILDING

- Safety at work and Ergonomics are in high roll in preparations
- Describe the principles of preparing the work place for stove building in accordance with ergonomic requirements
- Arrange materials and tools in the stove builder‘s work areas in accordance with ergonomic requirements
- Pay attention to good discipline, trained procedures, systematic steps in preparations, following the specific, site related working instructions

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ASSEMBLING ELEVATION EQUIPMENT

The greatest number of accidents occurred while working on the scaffolds and working surface and the next most when disassembling and assembling the scaffold. Accidents occurred also when the scaffold was raised and descended.

Describe the requirements for assembling the scaffolds and working on it.

Assemble scaffolds, following the instructions. Fill up the check list of

- Assembling the scaffold
- Disassembling the scaffold
- Scaffold maintanance check list

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MARKING OF THE BASE AND FOUNDATION OF A SOLID FUEL HEAT RELEASE APPLIANCE

- List, describe and identify marking and measuring tools and equipment

- Read technical drawings
  - Drawings shows exacts measures, which should be followed.
  - If there's of your opinion a mistake, contact the foreman to get the instructions to proceed.

- Perform marking of the base and foundation of a selected solid fuel heat release appliance
  - Double check the measurements between the drawings, stove and foundation.

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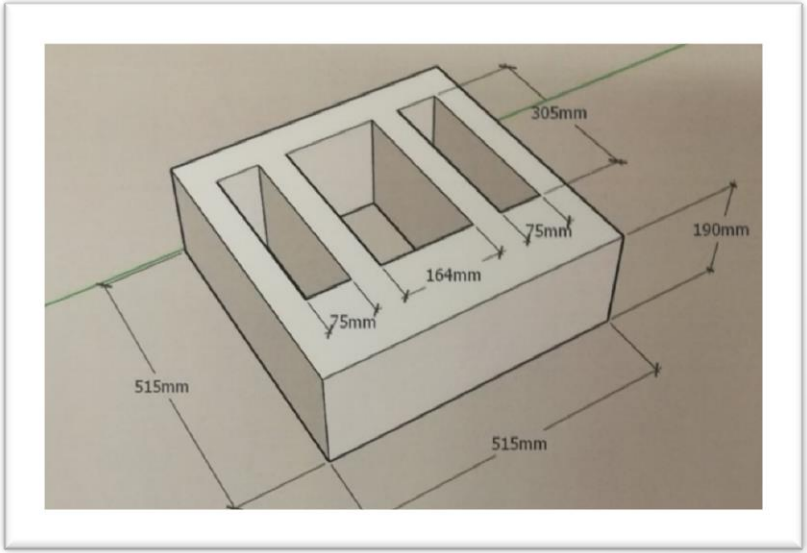
INSTALLATION AND EVALUATION OF THE BASE AND FOUNDATION

- **Describe technology, tools and materials for installation of the base and foundation.**
- **Install the base and foundation for a stove**
- **Usually the foundation is made of LECA-block, or it's delivered within the stove**



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STOVE BUILDERS' WORK ORGANISATION

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Documentation and scope of work

Examining existing documentation

Stove builder must examine existing building plans and drawings.

The documentation issued must include:

- Location of the heating appliance in the building;
- Number of heating appliances and smoke flues;
- Heat output of the appliance in kW;
- Type of fuel the appliance uses;
- Description of the location of the chimney and cleaning openings;
- Distance to flammable materials ;
- How the chimney can be accessed for cleaning

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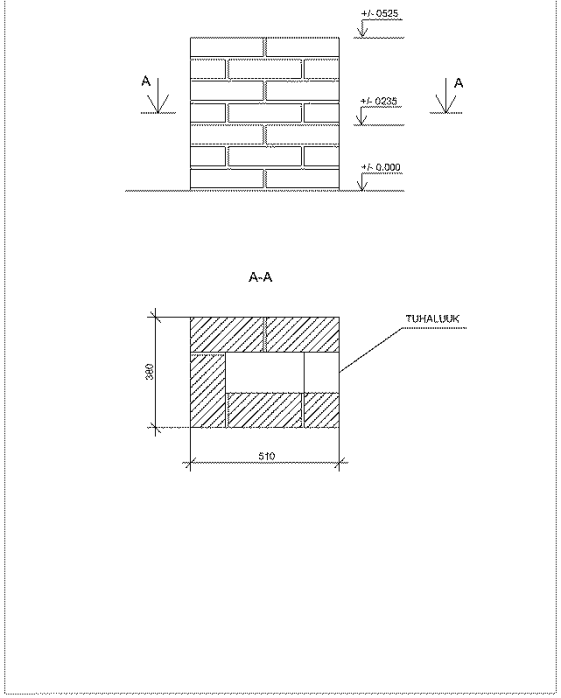
Material calculations

Calculate the amount of materials required.

For example, chimney calculation.
Exercise:
Chimney material firebrick 65 x 120 x 250mm
Filling between bricks 10mm
Chimney height 8,25m, flue size 140 x 270mm
How many bricks and how much mortar is needed to build the chimney if the mortar rate is 1kg per brick?



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Organisation of work

Planning working time

Usually stove builders work in small companies, including 1 master and 2-3 stove builders.
Master is responsible for customer consultation and calculations, also planning the stove/cooking stove/chimney.

Master assigns tasks to stove builders, makes a plan for all tasks on a given construction project.

The stove builders can be employed

- On permanent basis (working contract with set hours)
- On temporary basis (work contract agreed for a specific construction project)

If the agreement is on temporary basis, the payment can either be:

- Based on hours worked
- Based on tasks completed

Master stove builder knows the limits of competence of the worker and gives the tasks accordingly.

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Supply of materials and logistics plan

- The master calculates the neccessary materials for a project undertaken and is in charge of making the agreement with customer.
- The materials are usually taken to the site after the customer has made the payment for materials.
- Master stove builder can assign the task of delivery of materials to workers or order transport services directly from the supplier.
- Master stove builder needs to make sure all the materials needed for the construction of a certain appliance are delivered to the site in order to guarantee smooth building process.
- The stove builder working at the site must give notice of any shortage of materials in timely fashion in order to prevent work stoppage.

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Evaluation of work

Know and list the requirements for work quality

Master stove builder sets the criteria for work quality. The basis for quality criteria is set in national legislation (for example, construction law) and national standards for construction.
The quality criteria need to be clearly communicated to the workers.
For example:

- If a stove is built of ceramic tiles, then how big can be the space between the tiles in mm.
- In case of brick construction (fireclay bricks), the brick overlay needs to be at least one third.
- The construction needs to be level and following the corners specified in the technical drawings.

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Evaluation of work

Giving feedback

- Master stove builder gives constructive feedback to workers relating to the construction project.
- The feedback needs to be to the point and based on quality criteria.
- The stove builder needs to make sure the workers understand the tasks assigned to them and directions given.
- In evaluation of the work completed two main things are considered:
  - Is the task completed correctly, i.e. according to technical description;
  - The time taken to complete the task .

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Methods and tools (1)

Different methods of building and installation of heat release appliances:

The heat release appliances are mainly divided into 3 groups

1. The stoves built on site
2. The appliances made in factories
3. Combination of factory made inserts and heat storage modules

Building a stove on site also includes cutting details to measure.
This can be done:

- In the stove builders workshop, in this case on site only the assembly of details takes place;
- Cutting details on site, in which case the stove builder needs to ensure that all the surrounding surfaces are covered. For cutting on site a separate cutting area needs to be designated and made dust proof. Sometimes cutting on site is neccessary in case of more complex constructions.

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Methods and tools (2)

Tools for building and installation

Master stove builder needs to keep stock of following tools:

1. Electrical tools, including a tile cutter, clay mortar mixer, drill
2. Hand tools (hammers, levels, masonry trowels)
3. Finishing tools

The tools are kept in stock in the workshop and given out to workers based on the need of a given construction project.
The tools can be kept on site (if this is agreed with the customer) or delivered back to workshop at the end of the working day/workweek.

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Methods and tools (3)

Select methods and tools for a specific building/installation case

- Describe the type of tools you need and methods to build a stove of ready made (to measure) ceramic tiles with interior construction made out of shamott brick and schamott plates (including the fire box and flues) and connect the flue to chimney.
- Install a door to the combustion chamber.
- Choose correct materials for chimney connection.

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Development of VET Training on Energy Efficient Stoves and Fireplaces

Furnace and air heating. Wood fuel

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Furnace and air heating
Wood fuel

Wood fuel as a renewable raw material when properly used is classified as neutral to the formation of CO2.

- *The tree during its growth absorbs the same amount of carbon dioxide, which is released when it is burned.*
- *Carbon dioxide is also released during slow deterioration.*

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Furnace and air heating
Wood fuel

***BImSch* – V**

- Environment Air Protection Regulations
- Wood Fuel Requirements

§2 Terms and definitions

- Paragraph 9 natural raw wood:

Wood that has been exclusively machined and contaminated with only a small amount of pollutants

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Furnace and air heating
Wood fuel

BImSch – V

- Environment air protection regulations
- Wood Fuel Requirements

§3 Fuel types

- (1) Only the following fuels are allowed in the furnace structures according to § 1:

4 natural raw wood:

natural raw single firewood, including bark, in particular, in the form of chopped firewood and cord woods, as well as wood chips, brushwood and cones.

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Furnace and air heating
Wood fuel

§3 Fuel types

5a Wood briquettes:

Wood briquettes made of natural raw wood in the form of wood briquettes according to DIN 51731, October 1996 edition, or in the form of wood pellets in accordance with the requirements for the combustion technique of the DIN certification program plus "Wood pellets for use in small heat sources according to DIN 51731-HP 5" , August 2007 edition, as well as other wood briquettes or wood pellets from natural raw wood of equal quality,

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Furnace and air heating
Wood fuel

(**3**) The types of fuel mentioned in paragraph 1 in clauses from 4 to 8, as well as 13, are allowed to be used in furnace structures only if their moisture content is below **25%** in relation to the weight of dry fuel.

(**4**) Wood briquettes in accordance with paragraph 1, clauses 5a – 8 and 13 are not allowed to be made using bonding materials. An exception is the bonding materials from starch, vegetable stearin, molasses and **cellulose fiber**.

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Furnace and air heating
Wood fuel

Composite wood components

Wood is an inhomogenous fuel consisting of cellulose, lignin, water, resins, acids, oils, minerals, etc. Wood contains about 85% of volatile components, which are the main combustible substance of this solid fuel. Only about 15% is burned in solid state in the form of charcoal.

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Furnace and air heating
Wood fuel

Firewood preparation

3 different forms of the same fuel

- *Same calorific value*
- *Same weight*
- *But different properties when burning*

All photos ©Uwe Lamke

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Furnace and air heating
Wood fuel

Firewood preparation

large proportion of the bark is the cause of nitrogen oxide high content

burns slowly / ignites poorly

high rate of fire

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Furnace and air heating
Wood fuel

Firewood preparation for ignition

Firewood for ignition, finely planed

Ignition aids: wax-coated wood rolls

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Furnace and air heating
Wood fuel

General calculated values for mixed wood

@ 20% humidity
4.0 kWh/kg
Calorific value:
15 – 17 mJ/kg

Weight of different wood species

deciduous (beech)	500 kg/rm
conifers (fir)	350 kg/rm
wood pellets	650 kg/m^3

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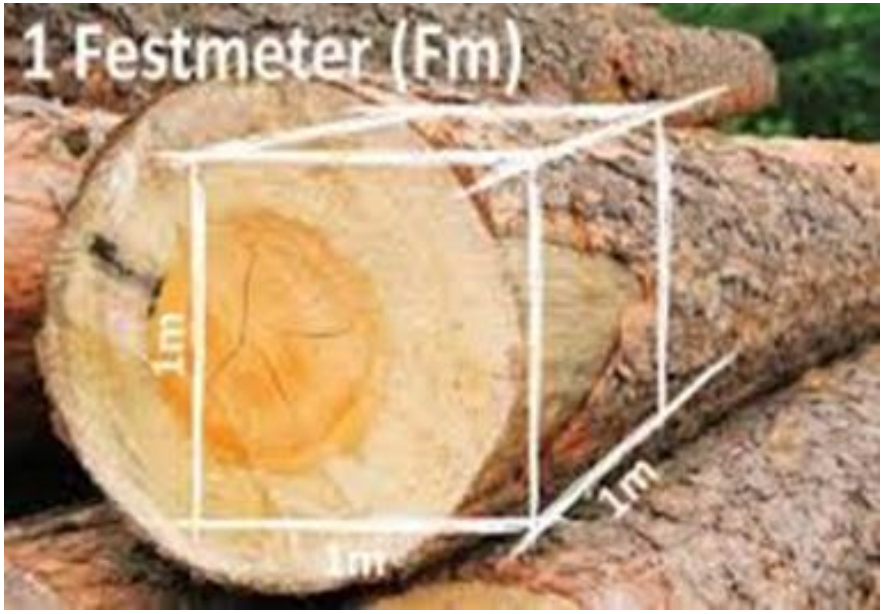
Furnace and air heating
Wood fuel

Units of measurement



Solid cubic meter (fm) is
1 cubic meter of wood
mass
without air.
1 solid cubic meter (fm) =
1 m3 of clear wood
Air 0%
Firewood ≫100%

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Furnace and air heating
Wood fuel

Units of measurement

1 raum-meter (rm) is
1 m^3 of chopped firewood
with a length of 1 m.
Air ≈ 33%,
Firewood ≫67%

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Furnace and air heating
Wood fuel

Units of measurement

1 shutraum-meter (srm) is
1 m3 of chopped firewood

Air ≈ 59-61%,
Firewood ≫ 45% if the size of a cord wood is 25 cm,
Firewood ≫ 43% if the size of a cord wood is 33 cm,
Firewood ≫ 39% if the size of a cord wood is 50 cm

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Furnace and air heating
Wood fuel

Recalculation

1 solid cubic meter (fm) of a round log = 1.4 rm of chopped firewood
= 1.2 rm cord woods, stacked in a row = 2 srm of cord woods in bulk
= 2.5 srm of fines (G 30)
1 rm of cord woods 1 m long, stacked in a row = 0.7 fm of a round log
= 0.8 rm of cord woods, stacked in rows = 1.4 srm of cord woods in bulk

1 rm of cord woods, stacked in a row и and prepared for burning
= 0.85 fm of a round log = 1.2 rm of cord woods
= 1.7 srm of cord woods, stacked in a row
1 srm of cord woods, prepared for burning and stacked in a row
= 0.5 fm of a round log = 0.7 rm of cord woods = 0.6 rm of cord woods in bulk

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Furnace and air heating
Wood fuel

Festmeter (1 FM)	Raummeter (1 RM)	Schüttraummeter (1 SRM)
keine Luft Würfel mit je 1 m Kantenlänge (= rechnerische Größe) **>> 100 % Holz**	**ca. 33 % Luft** Kiste = 1 m^3 voll geschichtet mit Scheitholz **>> 67 % Holz**	**55–61 % Luft** Kiste = 1 m^3 mit lose geschüttetem Scheitholz **25cm = 45 % Holz** **33cm = 43 % Holz** **50cm = 39 % Holz**

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Furnace and air heating
Wood fuel

Definitions

1 solid cubic meter (fm)

Unit of measurement of 1 m^3 of solid wood pulp

1 raum-meter (rm)

Unit of measurement for firewood stacked in rows or in bulk, which completely fill a volume of 1 m^3 (logs, cord woods, small round wood up to 12 cm)

1 shutraum-meter (srm)

Unit of measurement of 1 raum-meter of wood in bulk (cord woods, chips, sawdust, etc.)

1 ton is absolutely dry (to atro)

Unit of measurement for the weight of 1 ton of absolutely dry wood pulp.

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Furnace and air heating
Wood fuel

Average calorific value (H_i) of air-dried firewoods with residual moisture content of 15%:

Type of wood	Density	Calorific value		
Deciduous species	g/dm³	kWh/fm	kWh/rm	kWh/kg
Maple	600	2.600	1.900	4,1
Birch	640	2.700	1.900	4,3
Beech	680	2.800	2.100	4,0
Oak	680	2.900	2.100	4,2
Poplar	410	1.700	1.200	4,1
Willow	520	2.000	1.400	4,1
Deciduous	-	-	1.900	-

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Furnace and air heating
Wood fuel

Average calorific value (H_i) of air-dried firewoods with residual moisture content of 15%:

Type of wood	Density	Calorific value		
Coniferous species	g/dm³	kWh/fm	kWh/rm	kWh/kg
Douglas fir	470	2.200	1.700	4,4
Fir	430	2.100	1.500	4,5
Cedar	510	2.300	1.700	4,4
Larch	550	2.300	1.700	4,4
Pine	410	2.000	1.400	4,5
Coniferous	-	-	1.800	

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Furnace and air heating
Wood fuel

The relationship between water content and calorific value

With a change in humidity, the calorific value of firewood changes.

Storage conditions	Humidity (w)	Calorific value (H_i)
newly felled	50-60%	2,0 kWh/kg
for one summer	25 - 35%	≈ 3,4 kWh/kg
2 years	15 - 25%	>≈ 4,0 kWh/kg

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Furnace and air heating
Wood fuel

1 cord wood weighing 1 kg
contains 1 glass of water
with a capacity of 0.2 l

This water must be evaporated!

It is a power consumption!

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Furnace and air heating
Wood fuel

The relationship between water content (w) and humidity (u)

Water content (w)

It is the percentage of water in relation to the total mass, that is, the water content describes the water contained in the biomass, which consists of dry biomass and water volume.

Humidity (u) or moisture content

It is the percentage of water in relation to the dry substance, dry basis, that is, the water volume contained in the fuel divided by the dry biomass.

Water content w (%)	50	40	30	20
Firewood humidity u (%)	100	66,7	42,9	25

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Furnace and air heating
Wood fuel

Chemical composition (average values) of firewood
(under the article Struschka, Straub, Angerer: Emission of harmful substances from fixed heat-storing furnaces – IVD Uni Stuttgart Nr 23/1991)

Types of wood	In terms of dry fuel in [%]			
	Carbon	Hydrogen	Oxygen and Nitrogen	Total volatiles
Deciduous	49,0	6,0	44,6	85,0
Conifers	50,7	6,2	42,6	85,0

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Furnace and air heating
Wood fuel

Combustion data and chemical components

Fuel	Calorific value		Ash content	Nitrogen N	Chlorine Cl	Sulfur S	Melting point
	kWh/kg	MJ/kg	as % of weight	as % of weight	mg/kg of dry substance	mg/kg of dry substance	°C
Deciduous species	5,11	18,4	0,55	0,49	163	402	1.265
Coniferous species	5,23	18,8	0,79	0,14	87	234	1.398

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Furnace and air heating
Wood fuel

Proper ignition

Fully open the air supply for combustion!
Large cord woods are below.
Firewood is on top.
Ignition aids are between them.

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Development of VET Training on Energy Efficient Stoves and Fireplaces

No 2016-1-LT01-KA202-023161

VILNIAUS STATYBININKŲ RENGIMO CENTRAS	**VSRC** - Vilnius Builders Training Centre, Lithuania	www.vsrc.lt
KROSNIŲ MEISTRŲ GILDIJA	**KMG** – Association of Lithuanian Stove Builders, Lithuania	www.krosniumeistrugildija.lt
Wolfshöher TONWERKE	**Wolfshöher Tonwerke GmbH & Co. KG,** Germany	www.wolfshoehe.de
KVT Kütte- ja Ventilatsioonisüsteemide Teabekeskus	**KVT** - Centre for Adult Education, Estonia	www.kvtkoolitus.ee
SATAEDU	**SATAEDU** – Satakunta Educational Federation, Finland	www.sataedu.fi

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Development of VET Training on Energy Efficient Stoves and Fireplaces – ENEFFIS
No. 2016-1-LT01-KA202-023161

ENEFFIS

Training/Learning materials

Case Study

January, 2019

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ENEFFIS

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ENEFFIS Case Study

Prepared by: Kütte- ja Ventilatsioonisüsteemide Teabekeskus, Estonia

Corner stove in Tartu county

The stove was designed as part of a combination heating system to support an excisting thermal heat pump.

Weight of the stove ca 2500 kg, for measurements see appendix 1. The height of the stove is 2100 mm. For heating material firewood and wood briquet is allowed. Maximum load in one firering is 15 kg (maximum per heating session is 25 kg minimum 12,5 kg)
Heat accumulation period is 12-24 hours and the stove is calculated for 200 m3.

The stove complies to Estonian National Standard for heating systems EVS 812:3-2013 and European Standard EN 15544.

The stove is connected to Schiedel Rondo Plus modular ceramic chimney with a flue diameter 200mm.

Combustion chamber

Measurements: Height 600mm, width 450mm, depth 450mm. The combustion chamber is designed as UZ combustion chamber where the necessary air intake is through the slits in combustion chamber walls.
Materials used: Wolfshöher Tonwerke HBO+ schamott plates and bricks, Wolshöher Tonwerke mortar Unioversal Plus. Door Romotop KV205 with double glasing.

Flues

The first flue (1) starts from the top of the combustion chamber and continues straight to the top of the stove. In the first flue is also the valve (klappen) for directing the smoke gas straight into the chimney. The flue system continues with 2 parrallel flues (2) on either side of the stove. These flues direct the smoke gases down into the base of the stove. In the base of the stove is a horizontal flue (3) that directs the smoke gas into the last flue (4) that is situated at the back of the stove and through which the smoke is directed into the chimney. There is another valve (klappen) in the last flue. In the flues and in all construction of the stove where material comes into contact with smoke gases Wolfshöher Tonwerke schamott products are used (HBO and HBO+).

Connecting flue with chimney

The connecting flue measurements are 120 x 200 mm and for the connecting flue fireproof metal that has been insulated using Skamotec 225 Super-Isol has been used. For finishing the connecting flue it has been armoured and plastered with a heat resiliant elastic plaster (Mira 3130). The smoke gas maximum temperature in proper use of the stove is 250 C.

Finishing

The outer shell of the stove was constructed from fireclay bricks (Wienerberger). The shell is armored with heat resiliant reinforcement mesh (Silca) and plastered with heat resiliant elastic plaster (Mira 3130). Finally the stove is tiled with white mat tiles using the same plaster.

Picture 1. Base of the stove. Side walls of the air intake compensation chamber. The external air is warmed up before being directed into the combustion chamber.

Picture 2. Air intake from a compensation chamber from under the combustion chamber.

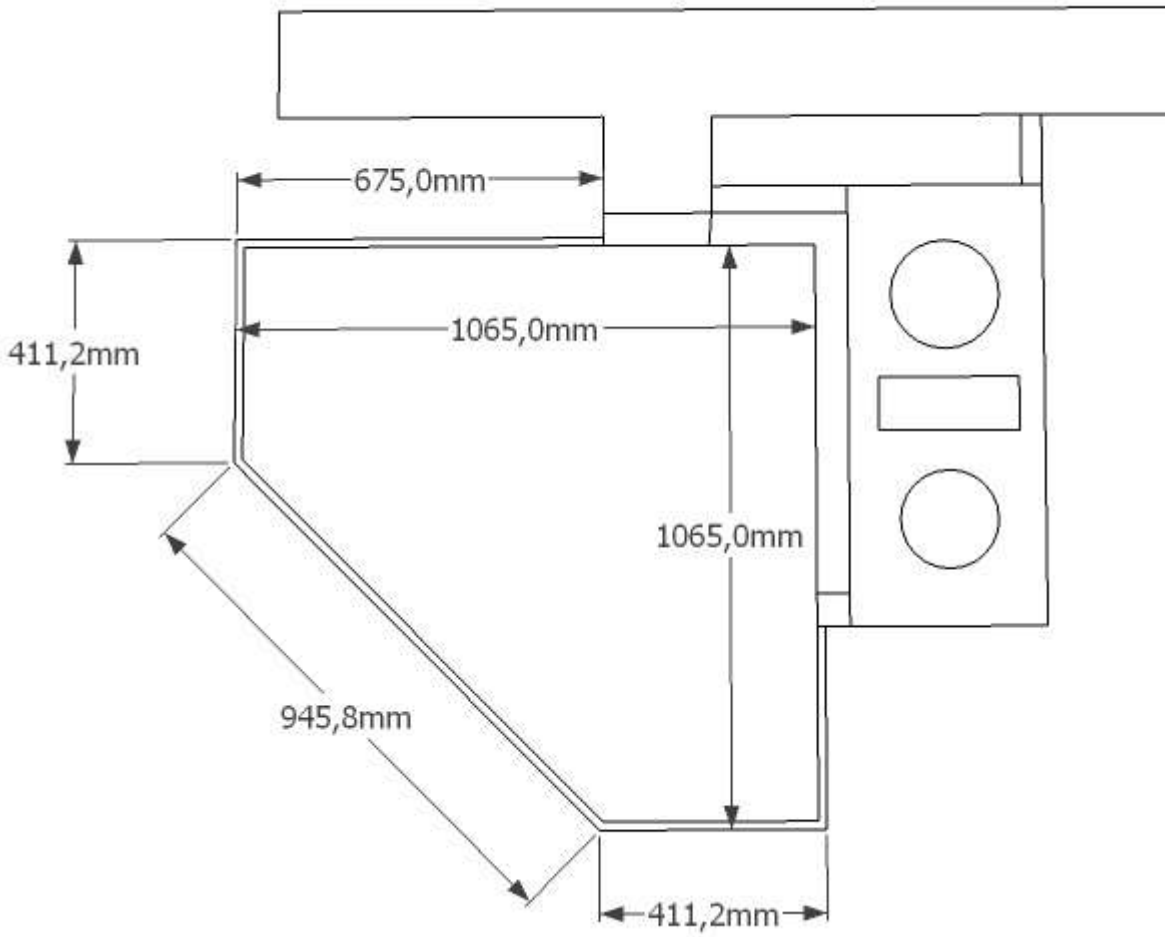
Picture 3. Combustion chamber from the top. Air canals are visible on 3 sides of the combustion chamber.

Picture 4. Base of the stove and combustion chamber from the front.

Picture 5. Mounting the door. Dry fitting and preparations for mounting the door.

Appendix 1

Drawing of the base of the stove.



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ENEFFIS Case Study

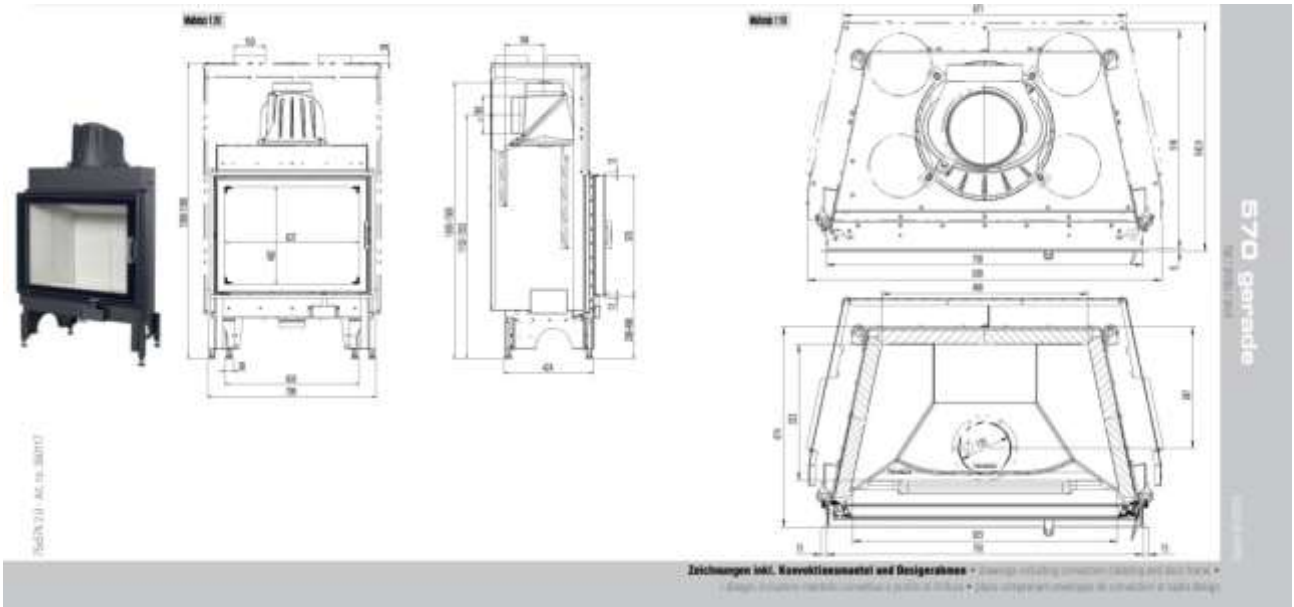
Ceramic Tiling of the Stove in A class house, Lithuania

Picture 1. The stove finished with ceramic tiles.

Description: Heat non-accumulating fireplace in an A class house

Air supply for combustion in energy efficient buildings is ensured by installation of a separate air intake channel. Through this channel the air from the chimney is directed into the firebox of the stove.

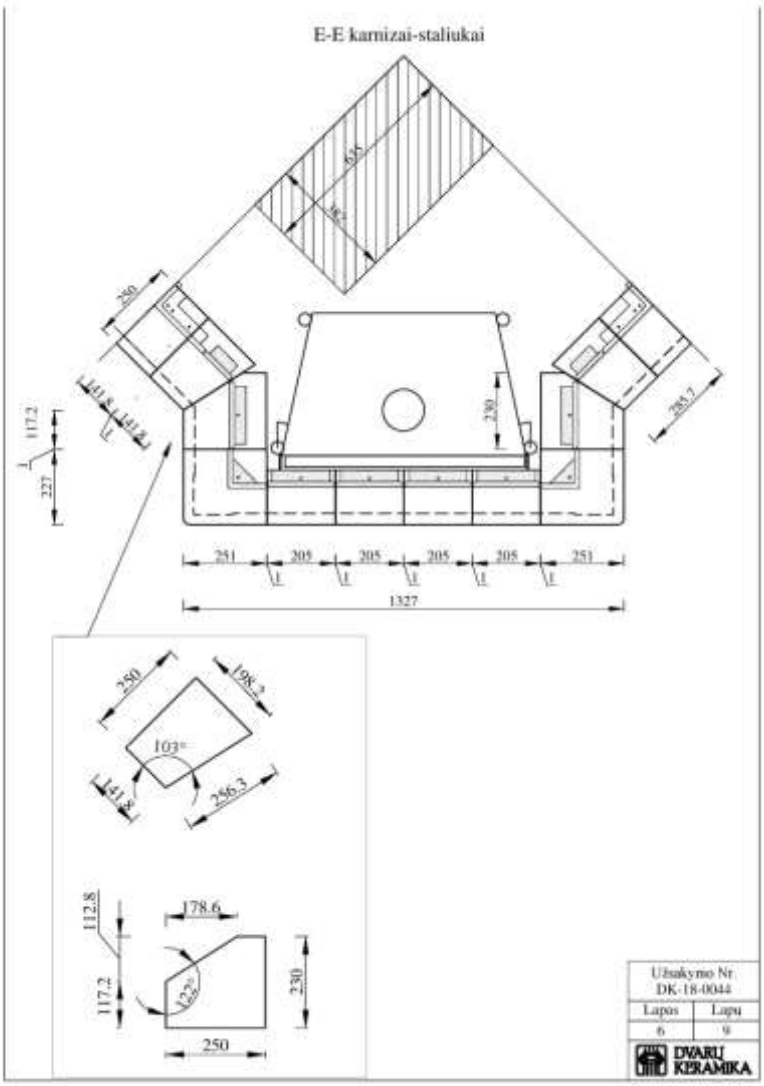
Picture 2. The installation of the firebox „Austro Flamm 75/57K“.



Picture 3. Technical drawing of the firebox.

Materials used for module construction and finishing:

- Ceramic tiles for the external module (UAB „Dvarų keramika“);
- Chamotte plate for the internal module (Wolfshöher Tonwerke GmbH & Co.KG)
- Mixture „Universal HM“ (Wolfshöher Tonwerke GmbH & Co.KG)



Picture 4. Production drawing.

Picture 4. Adjusting the stove to the interior style of the dwelling.

Two types of ceramic details were used for stove finishing – equal and embossed. Equal details were matched to modern solutions in the interior, and the embossed ones aligned with the accents of the interior.

Picture 5. The interior design solutions are replicated in the stove decoration.

The colours of the stove tiles were chosen according to the interior style of the dwelling. White colour was selected as the main one, so that the fireplace would stand out in the gray wall. Embossed details were decided in a "royal blue" colour. Decorating was done by hand drawing on the surface of glazed ceramics, which requires time and skill.

All photos provided by UAB „Dvarų keramika“, Lithuania: www.dvarukeramika.lt

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TECHNOLOGY CARD

SUBJECT: Joining angular elements of channels

AIM: To familiarize with flues from the “STANDART” system. Flue blocks N+F. To learn how to prepare a compound and join angular flues.

TASKS:

1. Prepare “DIDOTECT” adhesive.
2. Prepare angular elements.
3. Join two elements.
4. Check the joint.

REQUIRED KNOWLEDGE:

1. To know about joining adhesive.
2. To know about flue blocks, their sizes, usage.
3. To know how to use tools.
4. To know the succession of works.

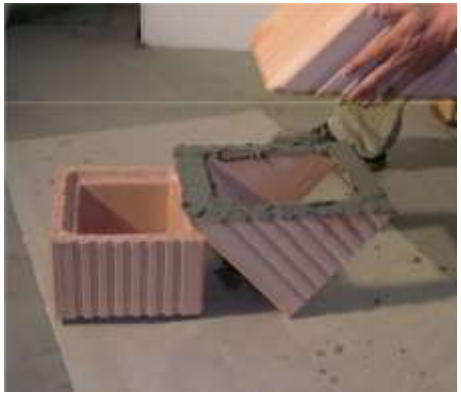
REQUIRED MATERIAL RESOURCES:

1. Stonemasonry workshop.
2. Angular flue blocks.
3. Stove builder's tools.
4. Personal safety and health equipment.

Duration: 8 hours

No.	Succession of tasks	Drawings, tables	Technological description
1	2	3	4
1.	Preparing adhesive (for training purposes).		Read the adhesive preparation instructions, check the mixer, put on safety goggles.

2.	Preparing tools.		Choose tools – masonry spatula, hammer-chisel, angle, spirit level, plumb-line, measuring instrument. Use safety goggles, construction helmet, gloves.
3.	Preparing of angular elements.		Remove dust off of the elements. Clean the joint surfaces of the elements and moisten with sponge.
4.	Applying adhesive.		Apply a 5 mm layer of adhesive using a spatula or trowel on the entire surface of the joint.

5.	Preparing angular elements for joining.		Lay the element in a suitable position so that the joint surface would be horizontal, then put the other element on it and press them together.
6.	Joining the elements.		

7.	Drying and checking of the elements.		Leave the joined elements to dry for 24 hours. Then check if they have bonded properly.

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OCCUPATIONAL SAFETY INSTRUCTIONS FOR PERSONS USING POWER TOOLS

General part

1. Power tools may only be operated by persons 18 or over, according to the established procedure, after they have passed health checks, and passed initial and worksite safety briefings.
   An employee must not use defective work tools and must inform a supervisor about them.
   The following is prohibited when operating powered equipment:
   a) using defective sockets, plugs, switches and other powered equipment installation;
   b) connecting several high-power devices to one electrical socket;
2. A person using power tools must know initial fire-fighting measures, their operating principle, usability, his actions in the event of fire. In the event of an accident the victim must be provided first aid, if necessary, an ambulance must be called.

Actions of persons using power tools during work

1. Using untested, unchecked, defective power tools is prohibited.
2. A power tool must be tested in idle operation conditions before starting to work.
3. In the event of any faults, work must be stopped immediately and the power tool must be disconnected from the socket.
4. The following is prohibited when working with power tools:
   a) handing a tool over to another person;
   b) disassembling or repairing power tools, cables, plugs, etc.;
   c) holding power cords and cables, touching a rotating power tool;
   d) working on ladders;
   e) leaving running power tools unattended.
5. The cables of power tools must be protected from accidental damage during work. Keep the cable of a power tool away from the moving parts of the tool during work.
6. The cable of a power tool must not touch the edges of a blade, wet or greasy surfaces, other cables.
7. Pulling, turning, bending the cable, placing loads on, and using defective, unsuitable cables for extension is prohibited.
8. Using gloves is prohibited when using a portable power drill. The part being drilled must be properly fixed.
9. Tools transported from one place to another must be disconnected from the electrical socket and carried by the frame, not the cable or working part.

10. Works at a height of 1 m or more above the overlay or the ground are considered to be works at height. Equipment for ensuring protection from falling must be used when carrying out such works.
11. Work at height of 5 m or more above the ground, overlay, scaffolding or floor are considered to be high-scaler work. Such works may be carried out by persons from the electrical engineering personnel, whose certificate includes the specific indication. A safety harness is the main equipment when carrying out such works.
12. When working on structures under which current-carrying parts are located, repair equipment and tools must be tethered to protect from falling.
13. Materials, tools and parts are hoisted to height using flexible rope made of an insulated material.
14. The use or power tools in open air during precipitation or using wet parts is prohibited.
15. Persons using power tools must monitor the conditions of the tools, cables, auxiliary devices, must stop working and inform supervisor if there’re any defects.

Employee's action after work

1. turn off and clean all powered equipment, check cables for damage;
2. take off and neatly store personal safety equipment;
3. place tools in respective storage locations;
4. wash up with soap and water.

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TECHNOLOGY CARD

SUBJECT: Installing the combustions chamber of a base stove

AIM:
1. Familiarize with and know the purpose of base stoves.
2. Learn how to install the combustions chamber of a stove.
3. Know the purpose and installation procedure of thermal insulation slabs.

TASKS:
1. Prepare and install a base.
2. Build the thermal insulation slabs.
3. Build the combustion chamber and install flues.

REQUIRED KNOWLEDGE:
1. To know the types and purpose of slabs.
2. To be able to carry out stonemasonry work.
3. To know stonemasonry techniques for the slabs.
4. To know how to install flues.

REQUIRED MATERIAL RESOURCES:
1. Stonemasonry workshop.
2. Thermal insulation and combustion chamber slabs.
3. Stonemasonry compounds.
4. Stonemasonry tools: *shovel, spatula, hammer-chisel, jointer, straight edge.* Control measurement devices: *spirit level, plumb-line, angle, measuring instrument.*
5. Personal safety and health equipment.

Duration: 24 hours

Nr.	Succession of tasks	Drawings, tables	Technological description
1	2	3	4
1.	Choosing the location of the stove and building the base.		Choose the stove location in the room. The base is built from ceramic blocks, using cement mortal. Work is carried out according to stonemasonry regulations.

2.	Installing insulation slabs.		Choose tools – masonry spatula, hammer-chisel, angle, spirit level, plumb-line, measuring instrument. Use safety goggles, construction helmet, gloves when chiselling blocks. Fill horizontal and vertical joints completely, maintain the verticality and horizontality of the structure.

3.	Installing the combustions chamber.		Prepare combustion chamber blocks by removing dust and moistening joint surfaces. Joints must be ~2-5 mm. Maintain verticality and horizontality. Clean the joints with a damp sponge. Use inserts in horizontal joints.

4.	Complete the combustion chamber.		Complete the combustion chamber using special blocks, on which the cover slab is mounted.

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OCCUPATIONAL HEALTH AND SAFETY

General part

1. Stove builders may only be persons 18 or over, with special training, after they have passed health checks, and passed initial and work site safety briefings.
2. A stove builder must:
   a) follow the instructions of higher qualification specialists;
   b) know principles of safety and work; not to put other people in danger;
   c) use personal and collective occupational safety equipment;
   d) inform higher qualification employees about injuries during work;
   e) follow internal rules of procedure, not to use alcoholic beverages and drugs during work, smoke only in designated areas;
   f) follow personal hygiene rules, keep workwear and shoes clean, keep the worksite, break rooms and lockers clean.
4. A stove builder has the right to:
   a) demand to ensure safe and healthy worksite for employees;
   b) demand to be informed about hazardous factors in the worksite;
   c) refuse to work if tools are faulty, equipment, environmental factors in the worksite cause danger to health and life, or collective or personal occupational safety equipment is not provided.
5. A stove builder must be familiar with fire safety instructions and follow them. He must know the location of fire-fighting equipment and be able to use it.
6. In the event of fire the stove builder must immediately inform fire fighters, call higher qualification employees to the location, extinguish the fire using available fire-fighting means.

Dangerous, hazardous and other risk factors and their impact on health. Necessary safety equipment

1. Dangerous, hazardous and other risk factors in the worksite of a stove builder:
   a) untidy worksite;
   b) not following safe operation rules of cranes for lifting materials;
   c) adverse weather conditions;
   d) noise.
2. Special scaffolding or mats with three rows of safety rails must be used when working more than 1.3 m above the ground or overlay. The bottom rail must fit snuggly on the mat and be at least 150 mm high. Using non-inventory, unusual elevation means is prohibited.

3. The total noise level in the worksite of the stove builder must not exceed 85 dBA, and air pollution must not exceed the limits established in hygiene norms.
4. Safety goggles must be used for eye protection when breaking holes through overlays or walls.

Employee's actions before commencing work

Before commencing work a stove builder must:

1. inspect the worksite for trash or waste, check the location and suitability of materials;
2. check tools, devices;
3. put on workwear, a helmet, a tool bag;
4. inform the supervisor about identified shortcomings.

OCCUPATIONAL SAFETY INSTRUCTIONS FOR PERSONS USING POWER TOOLS

General part

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2. An employee must not use defective work tools and must inform a higher qualification employee about them.
3. The following is prohibited when operating power equipment:
   a) using defective sockets, plugs, switches and other powered equipment;
   b) connecting several high-power devices to one electrical socket;
4. A person using power tools must know initial fire-fighting measures, their operating principle, usability, his actions in the event of fire. In the event of an accident the victim must be provided first aid, if necessary, an ambulance must be called.

Actions of persons using power tools during work

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11. Work at height of 5 m or more above the ground, overlay, scaffolding or floor are considered to be high-scaler work. Such works may be carried out by electrical engineering personnel, whose certificates include the specific indication. A safety harness is the main equipment when carrying out such works.
12. When working on structures under which current-carrying parts are located, repair equipment and tools must be tethered to protect from falling.
13. Materials, tools and parts are hoisted to height using flexible rope made of an insulated material.
14. The use or power tools in open air during precipitation, or machining wet parts is prohibited.
15. Persons using power tools must monitor the conditions of the tools, cables, auxiliary devices, must stop operating and inform the supervisor about any defects.

Employee's action after work

1. turn off, clean all electrical equipment, check cables for damage;
2. take off and neatly store personal safety equipment;
3. place tools in respective storage locations;
4. wash up with soap and water.

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TECHNOLOGY CARD

SUBJECT: Plastering of the external wall of a base stove.

AIM:

1. Familiarize with compounds for plastering of stoves.
2. Learn how to correctly plaster the external walls of the stove.

TASKS:

1. Prepare a wall for plastering.
2. Install the reinforcement mesh.
3. Plaster the wall using white plaster.

REQUIRED KNOWLEDGE:

1. To know the brand and purpose of plaster.
2. To know the technological requirements for plastering.
3. To know how to use special plastering tools.

REQUIRED MATERIAL RESOURCES:

1. Stonemasonry workshop.
2. Tools.
3. Natural white plaster compound.
4. Reinforcement mesh.
5. HM compound.

Duration: 8 hours

Nr.	Succession of tasks	Drawings, tables	Technological description
1	2	3	4
1.	Preparing the stove wall for plastering.		Read the instructions of the compound, check the mixer, put on safety goggles, mix the compound, remove dust from the wall, moisten the wall using a sponge and cover with HM compound.
			Install the reinforcement mess after applying the HM compound and cover with compound. This task must be carried out very diligently and special attention must be paid to corners.

2.	Plastering the surface.		Moisten the surface with water. Cover the surface with a plaster compound and sink in another mesh.

	Applying plaster.		Apply a 5 mm layer of plaster using a spatula or trowel on the entire plastered surface. Allow the plaster compound to start drying, then moisten it with a sponge and remove the resulting milky liquid.

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OCCUPATIONAL HEALTH AND SAFETY

General part

1. Stove builders may only be persons 18 or over, with special training, after they have passed health checks, and passed initial and work site safety briefings.
2. A stove builder must:
   a) follow the instructions of higher qualification specialists;
   b) know principles of safety and work; not to put other people in danger;
   c) use personal and collective occupational safety equipment;
   d) inform higher qualification employees about injuries during work;
   e) follow internal rules of procedure, not to use alcoholic beverages and drugs during work, smoke only in designated areas;
   f) follow personal hygiene rules, keep workwear and shoes clean, keep the worksite, break rooms and lockers clean.
4. A stove builder has the right to:
   a) demand to ensure safe and healthy worksite for employees;
   b) demand to be informed about hazardous factors in the worksite;
   c) refuse to work if tools are faulty, equipment, environmental factors in the worksite cause danger to health and life, or collective or personal occupational safety equipment is not provided.
5. A stove builder must be familiar with fire safety instructions and follow them. He must know the location of fire-fighting equipment and be able to use it.
6. In the event of fire the stove builder must immediately inform fire fighters, call higher qualification employees to the location, extinguish the fire using available fire-fighting means.

Dangerous, hazardous and other risk factors and their impact on health. Necessary safety equipment

1. Dangerous, hazardous and other risk factors in the worksite of a stove builder:
   a) untidy worksite;
   b) not following safe operation rules of cranes for lifting materials;
   c) adverse weather conditions;

d) noise.

2. Special scaffolding or mats with three rows of safety rails must be used when working more than 1.3 m above the ground or overlay. The bottom rail must fit snuggly on the mat and be at least 150 mm high. Using non-inventory, unusual elevation means is prohibited.
3. The total noise level in the worksite of the stove builder must not exceed 85 dBA, and air pollution must not exceed the limits established in hygiene norms.
4. Safety goggles must be used for eye protection when breaking holes through overlays or walls.

Employee's actions before commencing work

Before commencing work a stove builder must:

1. inspect the worksite for trash or waste, check the location and suitability of materials;
2. check tools, devices;
3. put on workwear, a helmet, a tool bag;
4. inform the supervisor about identified shortcomings.

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ENEFFIS

ENEFFIS
Training/Learning materials/ Technology Card

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TECHNOLOGY CARD

SUBJECT: Installation of the external wall of a base stove.

AIM:
1. Familiarize with panels for external walls.
2. Learn how to install a smooth wall and corners using the panels.
3. Learn how to install the cover of the stove.

TASKS:
1. Install the external wall of a base stove.
2. Install cover of a base stove.

REQUIRED KNOWLEDGE:
1. To know the brand and purpose of external wall panels.
2. To know bearing blocks and cover panels.

REQUIRED MATERIAL RESOURCES:
1. Stonemasonry workshop.
2. Schamott panels.
3. HM adhesive compound.
4. Bearing schamott blocks.
5. Stonemasonry tools: *electrical mixer, spatula, hammer-chisel, straight edge.* Control measurement devices: *spirit level, plumb-line, angle, measuring instrument.*
6. Personal safety and health equipment.

Duration: 16 hours

No	Succession of tasks	Drawings, tables	Technological description	
1	2	3	4	
1.	Preparing panels for installation		Remove dust and moisten the panel. Apply compound to the edge of the panel, cover the entire surface of the edge.	

2.	Installing the panels.		The panels are installed by pressing a panel with adhesive to another panel, remove excess adhesive using a trowel and sponge. Vertical joints must be reinforced. A 2-3 cm gap is left between the combustion chamber and external wall of the stove. Do not mix too much HM compound; it may only be used for 20 minutes after mixing.	

3.	Installing corners.		The panel must be chopped using a chisel or cut a respective size so that vertical joints could be reinforced when installing corners. Carefully check verticality.	

4.	Installing panels around the door of the combustion chamber.		Mark a panel and cut it according to the dimensions of the opening of the combustion chamber. Top panels are installed whole. Check verticality and horizontality.	

5.	Preparing cover panels.		Firstly measure and cut the cover panel. The panel is prepared for installation just like all others.	

6.	Installing cover panels.		Apply compound to the entire perimeter, place the panel on top and press it on. After that install the second panel by using an insert with compound and press both panels together. Clean off excess compound.	

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OCCUPATIONAL HEALTH AND SAFETY

General part

1. A stonemason violating the requirements of these instructions is a subject to disciplinary, administrative, criminal and material liability according to the provisions of Lithuanian laws depending on the nature and consequences of such violation.
2. Stonemasons may only be persons 18 or over, with special training, after they have passed health checks, and passed initial and work site safety briefings.
3. A stonemason must:
   a) follow the instructions of employers;
   b) know principles of safety at work; not to put other people in danger;
   c) use personal and collective occupational safety equipment;
   d) inform higher qualification employees about injuries during work;
   e) follow internal rules of procedure, smoke only in designated areas;
   f) follow personal hygiene rules, keep workwear and shoes clean, keep the worksite, break rooms and lockers clean.
4. A stonemason has the right to:
   a) demand to ensure safe and healthy worksite for employees;
   b) demand the employer to be informed about hazardous factors in the worksite;
   c) refuse to work if:
   s/he is not prepared for working safely;
   tools are faulty, equipment and environmental factors in the worksite cause danger to health and life;
   collective or personal occupational safety equipment is not provided.
5. A stonemason must be familiar with fire safety instructions and follow them. He must know the location of fire-fighting equipment and be able to use it.
6. In the event of fire the stonemason must immediately inform fire fighters, call managing employees to the location, extinguish the fire using available fire-fighting means.

OCCUPATIONAL SAFETY INSTRUCTIONS FOR PERSONS USING POWER TOOLS

General part

1. Power tools may only be operated by persons 18 or over, according to the established procedure, after they have passed health checks, and passed initial and worksite safety briefings.
2. An employee must not use defective work tools and must inform a supervisor about them.

The following is prohibited when operating powered equipment:

a) using defective sockets, plugs, switches and other powered equipment installation;
b) connecting several high-power devices to one electrical socket;

3. A person using power tools must know initial fire-fighting measures, their operating principle, usability, his actions in the event of fire. In the event of an accident the victim must be provided first aid, if necessary, an ambulance must be called.

Actions of persons using power tools during work

1. Using untested, unchecked, defective power tools is prohibited.
2. A power tool must be tested in idle operation conditions before starting to work.
3. In the event of any faults of power tools, work must be stopped immediately and the power tool must be disconnected from the socket.
4. The following is prohibited when working with power tools:
   a) handing a tool over to another person;
   b) disassembling or repairing power tools, cables, plugs, etc.;
   c) holding power cords and cables, touching a rotating power tool;
   d) working on ladders;
   e) leaving running power tools unattended.
5. The cables of power tools must be protected from accidental damage during work. Keep the cable of a power tool away from the moving parts of the tool during work.
6. The cable of a power tool must not touch the edges of a blade, wet or greasy surfaces, other cables.
7. Pulling, turning, bending the cable, placing loads on, and using defective, unsuitable cables for extension is prohibited.
8. Using gloves is prohibited when using a portable electrical drill. The part being drilled must be properly fixed.
9. Tools transported from one place to another must be disconnected from the electrical socket and carried by the frame, not the cable or working part.
10. Works at a height of 1 m or more above the overlay or the ground are considered to be works at height. Equipment for ensuring protection from falling must be used when carrying out such works.
11. The use or power tools in open air during precipitation or working with wet parts is prohibited.
12. Persons using power tools must monitor the conditions of the tools, cables, auxiliary devices, must stop working and inform supervisor if there’re any defects.

Employee's action after work

1. turn off, clean all powered equipment, check cables for damage;
2. take off and neatly store personal safety equipment;
3. place tools in respective storage locations;
4. wash up with soap and water.