ABCAT®
WOODSMOKEFILTER

HANDBOOK

BURNING WOOD

IN A WOOD STOVE WITH AN

ABCAT® WOOD SMOKE FILTER

IN THE CHIMNEY

Your dealer:

Index

1. FUEL

1.1 Suitable / unsuitable

Suitable fuel for use in a wood stove without or with ABCAT® are:

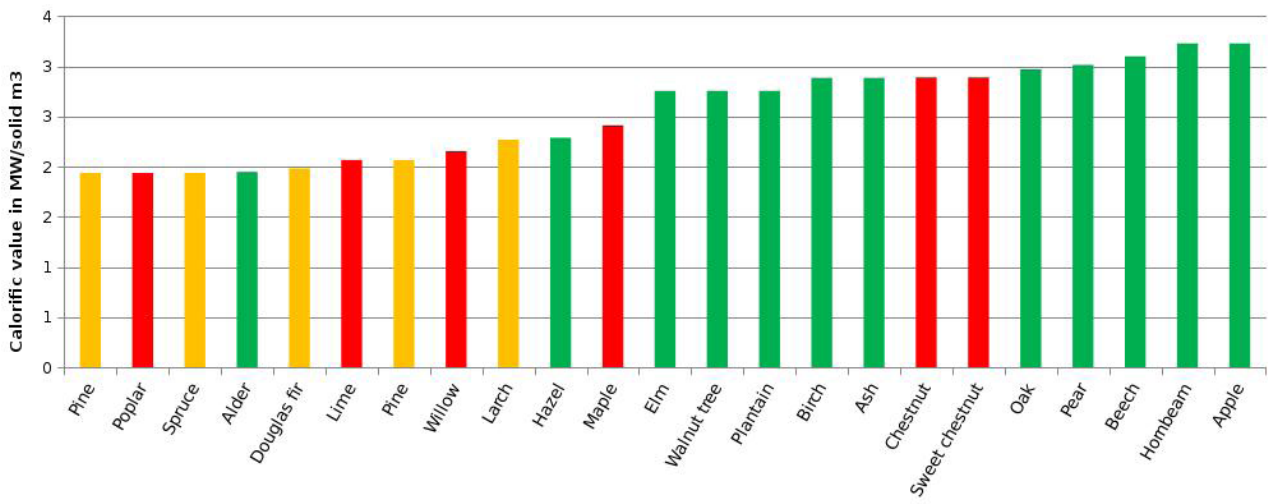
- fire wood with a circumference of max. 30cm, 12-15% moisture (see Ch. 1.6)
- briquettes of compacted, clean wood without additions (such as glue)

Unsuitable for wood stoves (with an ABCAT®) are:

- coal (because of calcium containing components)
- lignite (because of sulfuric odor)
- pellets (because of a relative high fly ash content)
- treated wood (preserved, glued, painted, etc)
- wood with nails, screws or other types of metal

1.2 Types of wood

Energy from native wood: overview of caloric value and odor impact
(the caloric value is the amount of heat that is released when the wood is completely combusted)



Green = Suitable wood / Orange = Less suitable wood / Red = Unsuitable wood

Explanation: the ***red*** colored wood types are classified as unsuitable because of the high concentration of odor which is released upon combustion and which are generally considered to have an unpleasant smell. The wood types indicated with either ***red*** or ***orange*** are classified as not or less suitable because:

- of the relatively high ash content en particulate emission;
- they gasify too fast in the stove with an increased risk of emitting unburnt wood gas;
- they contain much resin which produces relatively much soot-forming components;
- they produce much odor which is generally considered to have an unpleasant smell upon combustion.

Exotic types of wood (eg. tropical hard wood) produce a different (exotic) wood smoke odor. These types of wood can contain resin which, upon combustion, produces an irritating and annoying odor.

Small pieces of pine wood are very suitable to start a fire with. They burn easy and fast. However, pine is unsuitable to use as main fire wood because of this rapid combustion. Most wood stoves are not designed to cope with this rapid combustion and will have a significantly increased emission.

1.3 Moisture

Fresh wood contains about 50-75% moisture. This is both free and fixed water. Air dry wood has a moisture content of about 12-15%. This is the fixed (cell- and chemically bound water) water content. This fixed moisture can only be removed by exposing the wood to very high temperatures, such as in a fire.

Wood which is suitable for burning has a moisture content of about 12-15%.

As an example: 600 gr beech with 15% moisture contains 90 grams of water. See the picture to the left.

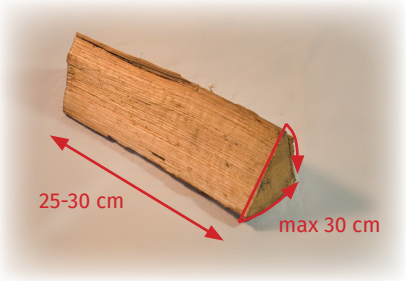
In heavier types of wood the moisture content of the living tree is lower than in lighter types of wood.

90 ml moisture in 600 gr beech (15% moisture)

Evaporating water requires energy and therefore takes away some efficiency. Water vapor in the stove reduces the fire-temperature, causes a poor combustion, condensate in the chimney and a lot of mission of smoke and odor. Therefore it is important to use fire wood with a moisture content of 12-15%.

1.4 Wood splitting

Wood can be split easiest when it is still fresh. Wood should be split into pieces with a circumference of maximum 30 cm.
A good length for fire wood is about 25-30 cm.



Split wood

1.5 Drying and storing wood

Wood dries at the cut of (front and back) side. The moisture moves through the small channels in the wood slowly to evaporate. Shorter cut wood dries faster since there is less distance for the moisture to cover before reaching the front or back side. The thickness of the wood barely influences the time required for drying.

Sufficiently dried wood has a moisture content of about 12-15%. The moisture content can be determined by measuring with a wood moisture meter. Using this meter correctly is important, since otherwise incorrect values can be measured. The next page shows, how to use a moisture meter correctly.

There is a general misconception that fire wood is suitable to burn after 2 years of drying. The only correct way to determine if the wood is ready for use in the stove, is by measuring the moisture content. In some drying setups wood can be dried sufficiently within one year. However, if the setup is wrong, wood can still be too moist to use in the stove after several years. Furthermore, if drying takes a long time, mold and fungi can develop which can pose a health risk.

Fresh or moist wood should always be stored outside, preferably under a roof to protect it from rain. Never store fresh or moist wood indoors, for example in a closed garage. The wood can not dry properly and the aforementioned mold can develop and cause a health risk. Sufficiently dry wood (12-15% moisture) can be stored indoors without any problems.
The moisture that evaporates from the wood makes the air more moist. Moist air is heavier than dry air. Moist air will fall to the bottom of the wood stack. It is important that this moist air can then be carried away by the wind. This functions best when there is space between the stacks of wood and when the base of the wood stack is lifted about 30 cm of the ground. Wood dries by wind and not by sun!

Below an example of a suitable drying setup for fire wood.

Drying setup, lifted approx. 30 cm of the ground with space between the rows of wood

1.6 Measuring moisture content

To determine the average moisture content of a piece of firewood, first, the wood has to be split in two. The moisture content should then be measured on the depicted three locations, crosswise to the grain of the wood. Sum up the three percentages and divide by three. The result is the average moisture content of the piece of wood. When the average moisture content is 12-15%, the wood is suited for use in a wood burning stove.

Split wood trough the middle

Measure moisture content of the fresh split surface, crosswise to the grain, at these points

sum up % of points 1, 2 and 3, then divide by 3
= average moisture content of piece of fire wood

2. STOVE

2.1 Types

There are many different brands and types of wood burning appliances.

In general the following types are suitable to responsibly burn wood:

- free standing stoves, wall mounted stoves and cooking stoves in kitchens;
- build in or insert fireplaces;
- tiled- or soapstone stoves which buffer and slowly deliver heat;
- wood fired central heating stoves and cookers.

Aforementioned appliances are in principle suited to be used in combination with an ABCAT® wood smoke filter. It is important that the wood smoke at the location of the ABCAT® is regularly at least 300°C. The temperature may not exceed 700°C.

Unsuitable to responsibly burn wood are:

- open fireplaces;
- garden fireplaces and fire pits.

2.2 Requirements

The most important requirements for a wood burning stove are:

- closed combustion chamber;
- heat output that fits the space where heat is required;
- supply of combustion air that fits the heat output
- combustion air that reaches the entire combustion zone;
- sufficiently high or long combustion zone;
- optimal heat transfer to the surroundings;
- sufficient exhaust of smoke, where the smoke has sufficient temperature and climbing power.

3. CHIMNEY

3.1 Chimney requirements

The most important chimney requirements are:

- a smooth inner lining;
- goes as straight up as possible;
- insulated;
- floor supports to carry the weight of the chimney;
- no unsupported weight may rest on the ABCAT®;
- diameter of the chimney has to be in line with the heat output of the stove. You may assume the diameter prescribed by the stove manufacturer is sufficient;
- chimney exhaust has to be sufficiently high and free;
- smoke should be able to rise and/or be carried away by the wind and as such be diluted in the atmosphere;
- exhaust may not be hindered by others roofs, trees or buildings;
- chimney draft or negative pressure in the chimney should be at least 15 Pa.

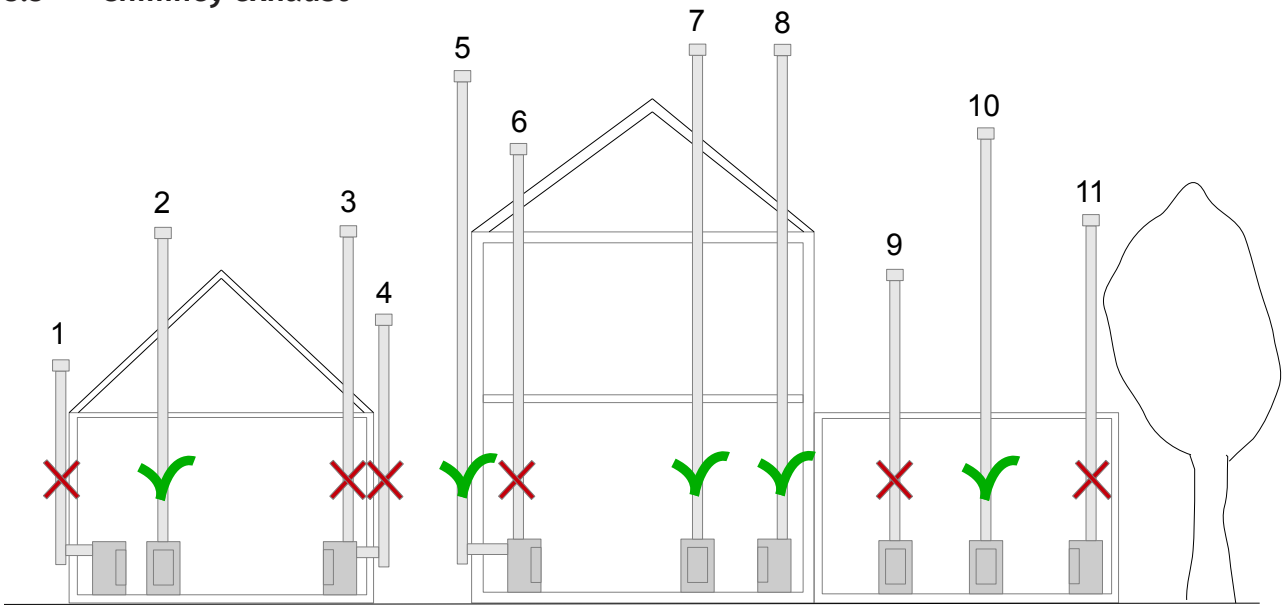
The stove requires 12 Pa and the ABCAT® 3 Pa draft. Your seller can measure this. In case the negative pressure is not known, the following should be taken into account: The chimney is at least 5 meters high, measured from the exit of the stove. Of this length, at most the first 2 meters is without insulation. When there is insufficient draft the chimney can be extended or a flue gas fan can be installed.
To prevent raining or blowing in, a hood can be installed.

3.2 Chimney height

The chimney draft is a result of the rising of hot air. Hot air expands and thereby weights less than the surrounding cold air. Heavy, cold air drops and light, warm air rises. The bigger the temperature difference, the bigger this climbing power or potential. The same principle is the reason, a hot air balloon can fly.
The longer the chimney, the more draft can be generated. Presupposed the wood smoke does not cool down too much in the chimney. A well insulated, straight chimney, 6 meters tall generates two times more draft than a 3 meter tall chimney.
The rising of air and/or smoke in the chimney causes the smoke to be removed ***and*** causes the stove to suck in combustion air. A chimney that does not function properly therefore also sucks in less air through the stove. This will lead to an unintentional lack of air to the stove and fire, poor burning and a considerable increase of the emission.

To be able to burn a stove properly, a straight chimney of at least 5 meters high, measured from the stove exhaust, is required. Of this chimney, at most the first 2 meters is without insulation. When there is insufficient draft, the chimney can be extended or a flue gas fan can be installed.

3.3 Chimney exhaust



Explanation for situations 1 to 11:

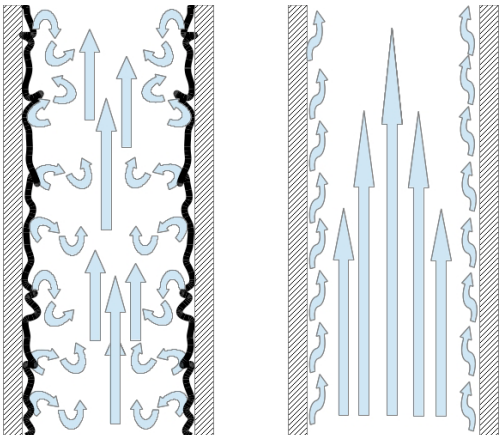
1. chimney too short, exhaust below roof
2. chimney is at least 50cm above roof
3. chimney too close to house on the right
4. chimney too close to house on the right, exhaust below roof
5. chimney sufficient height
6. chimney below roof
7. chimney sufficient height and exhaust minimally 50cm above roof
8. chimney sufficient height and exhaust minimally 50cm above roof
9. chimney too short, exhaust too close to house on the left
10. chimney sufficient height and exhaust has sufficient distance to house left and tree
11. chimney too close to tree and not minimally 50cm above tree top

3.4 Chimney maintenance

Soot of a wood fire consists of carbon which is contaminated with many chemical components. Tar contains many hydrocarbons and acids. The deposition of tar in a chimney is called creosote. When creosote comes into contact with water, organic acids can be formed and affect metal components. This decreased the lifetime of the chimney.

When a chimney is swept regularly, the inner wall remains smooth. The wood smoke can flow through the chimney without much turbulence. However, when there is a lot of deposit on the chimney wall, a lot of turbulence is generated causing the wood smoke to flow with less ease. This decreases the chimney draft.

Next to reduced draft, the risk of a chimney-fire increases with a dirty chimney. The deposition of creosote is basically a deposition of unburnt fuel.



Dirty and swept chimney

4. STARTING THE FIRE

4.1 How does wood burn?

In a fire it is not the wood that burns but rather it is the wood gas that burns. Wood gas is produced when wood is heated. The wood gas burns because it reacts with oxygen from the combustion air that is sucked into the stove. This process is very visible, since it produces the flame that can be seen in the stove. Aside from oxygen, this reaction also requires a sufficiently high temperature.

4.2 Top down fire starting

The best way to start a fire is using the top down method. This method is also know as the Swiss or upside down method. This way of lighting the fire is called upside down because the fire burns from top to bottom. The hot wood gas does not collide with cold fire wood on top of the flame, as is the case with lighting the fire from the bottom. Since the wood gas does not cool down because of any contact with cold wood, the flame can burn freely; most wood gas passes trough the flame and burns up. When the heat of the fire on top has heated the wood beneath and wood gas is produced, these pieces of wood will also start to burn. So, the wood only starts to burn when it is ready to do so.
Another advantage of this way of lighting the fire is that the stove and chimney can heat up slowly. In particular the chimney needs heat to produce draft and suck in combustion air to the stove. The amount of combustion air required increases as the fire grows. Simultaneously the chimney heats up and produces more draft. There is a balance in these factors that is respected using the upside down firing method.

When a fire is lighted from the bottom the hot wood gas will cool down upon contact with the cold peaces of wood on top. The combustion will stop at that point since there is insufficient temperature for the combustion reaction. As a result the emission of wood gas and other unburned components increases. This leads to more condensation in the chimney and a higher emission of harmful components, leading to a higher impact on health and environment. Basically the stove is required to start of full throttle while everything is still cold, the chimney produces close to no draft and there is insufficient combustion air sucked into the stove. This leads to a higher emission.

To light the fire upside down a fire starter or wood-wool fire starters. Do not use newspapers, starter liquids, etc.

RIGHT
Upside down lighting with a fire starter on top

WRONG
Bottom up lighting produces much smoke and emission

5. FIRE MAINTENANCE

5.1 Adding fire wood

The right moment to add fire wood to the stove, is when the last small flames are about to extinguish and there is a nice glowing bed of charcoal.

Do not overfill the stove! Always make sure the flames are visible in the stove. When the flames disappear behind the baffle plate, too much wood was added. This leads to extra emission and a loss of efficiency. Let the stove burn trough the wood (do not close the air intake to slow down the combustion!) and use less wood for the next refueling. To asses how much wood per charge should be added the stove manual can also be consulted.

In adding wood to the stove it is important that the combustion air can reach the fire. Therefore always place the wood in such a way that the air can flow through the wood properly.

The combustion air should be regulated in such a way that lively flames can be seen. When the fire looks like it is blown into, the stove gets too much air. When the flames are dark and move in slow motion, the stove gets too little air. If you are in doubt it is better to provide the stove with more rather than less combustion air. After all, both the fire and the ABCAT® need air.

When your wood stove has bottom air or an air supply via the ash tray, than it is better to keep this closed if possible. When air is blown into the ash, the emission of particulates increases significantly since bottom ash is swirled up (and turned into fly ash).

Below examples of how wood should and should not be added:

RIGHT
Combustion air can flow properly between the pieces of wood

WRONG
Too big, not split wood
The big block ignites difficult and suffocates the fire

WRONG
Stacked too close together
The wood suffocates the fire

6. CATALYST

6.1 ABCAT®

The ABCAT® has been developed to reduce the emission of wood smoke from the chimney of wood burning stoves. Particular attention has been given to reducing the odor of the wood smoke. The ABCAT® is installed directly on top or behind the (new) stove as first chimney segment.
The ABCAT® contains a mixed bed palladium/platinum (precious metal) catalyst and is fully constructed from stainless steel. The ABCAT® is robust and operation and maintenance are easy.
The ABCAT® is ***not*** a tool to compensate an inferior installation or poor operation! Of great importance is that the whole firing process satisfies the aspects addressed in this handbook. Only then the ABCAT® can optimally contribute to reducing the emission. After all, a poorly maintained car with a badly running engine does not turn into a perfect car by only installing a filter in the exhaust.

It is important that the ABCAT® fits the output of the stove. Below the heat output and the appropriate ABCAT® are listed:

ABCAT® 125 mm => up to approx. 5 kW
ABCAT® 150 mm => up to approx. 8 kW
ABCAT® 180 mm => up to approx. 12 kW
ABCAT® 200 mm => up to approx. 15 kW

When the ABCAT® is installed on a stove with a too high heat output, it is not equipped to the task and can therefore function less.

6.2 Functioning

A simple description of what the ABCAT® does: What did not combust in the stove gets a second chance in the ABCAT® to combust.
The filter in the ABCAT® consists of a palladium/platinum catalytic converter. The catalyst material is enclosed in a round module which functions as a sort of permeable valve in the stovepipe. The major part of the wood smoke goes through the catalyst. The catalyst cracks components that did not burn in the flames, such as hydrocarbons. These components give the color and odor to the wood smoke. Next to the catalytic function, the catalyst also acts like a mechanical filter, filtering out part of the particulates (fly-ash).

A catalyst needs temperature and oxygen from the wood smoke to crack and burn (oxidize) chemical components. The wood smoke temperature needs to be more than 300°C for an optimal functioning of the ABCAT®. For this reason the ABCAT® is installed directly after the stove. As a result of the after burning effect in the catalyst, the temperature inside the ABCAT® will increase.
After the ABCAT® the temperature drops again. When the optional thermometer above the ABCAT® indicates a temperature of more than 250°C, the ABCAT® is at optimal operating temperature.

6.3 Thermometer

Optionally a bi-metal insert thermometer with a range up to 500°C can be installed in the flue. With this thermometer the wood smoke temperature, and thus the operating condition of the ABCAT®, can be monitored. It is highly recommended to use the ABCAT® in combination with such a thermometer.

When a thermometer is installed it is recommended to place the thermometer about 75cm above the stove. There the wood smoke flow is laminar and the highest temperature will be in the center of the stove pipe.

To install the thermometer a hole of Ø10mm has to be drilled in the stove pipe. Then, if needed, the edge of the hole has to be sharpened with a countersink drill. The threaded cone is screwed into the hole where it fixes itself on the sharp edge of the hole.

The shaft of the thermometer is inserted to the point where the tip of the shaft is approximately in the center of the stove pipe. This is where most wood smoke passes and where the temperature is the highest.

The thermometer regularly needs to be taken out to clean the shaft. This is required since over time the shaft gets covered with soot. Soot is an excellent insulator which eventually results in deviations and too low temperature readings.

6.4 Installing ABCAT®

The basic situation like described in the conditions needs to be safeguarded. Summarized this means that the wood stove, the chimney, the fuel and the operation need to bee all right. Only then the ABCAT® can function optimally. When this basic situation is not secured, no liability can be claimed from the producer. The ABCAT® needs to be installed professionally.

The ABCAT® needs to be accessible for operation and regular inspection and maintenance. For that reason the ABCAT® needs to be installed as close to the stove as possible. Installation is as easy as replacing the first stove pipe segment after the stove with the ABCAT® stove pipe segment.

The ABCAT® stove pipe segment can be installed in any position (horizontally, vertically or in any position in between).

6.5 Using and cleaning the ABCAT®

Check the product prior to installation. Pay special attention to damages or abnormalities that hinder a safe use of the ABCAT®.

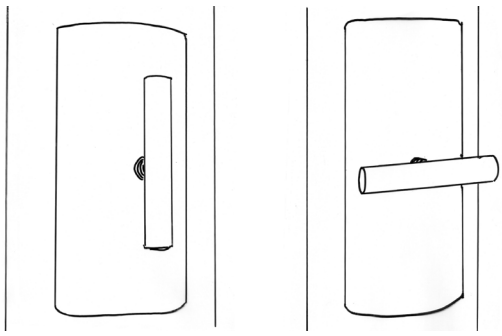
When the ABCAT® is installed the following has to be taken into account:

- BE CAREFUL: The handle of the ABCAT® can be hot!
  Use gloves when operating the handle. Do not turn the handle to the service position so that the ABCAT® can be taken out of the stove pipe! The ABCAT® may only be taken out and serviced when the stove is not burning and is cold.
- Never use the ABCAT® in combination with other fuel than indicated in this manual or with chimney-cleaner or similar products!
- In the lighting phase of the fire the combustion air inlet(s) should be fully open.
- Light the fire top down and always use suitable fire wood.
- The air intake(s) should be opened as much as possible, taking into account the behavior of the flames as described in this handbook. Both the fire and the ABCAT® need air. The supply of bottom air should be left closed as much as possible.
- At all times ensure sufficient ventilation and combustion air can enter the space where the stove is installed.
- The optimal minimum operating temperature of the ABCAT® is between 300 and 350°C. At lower temperatures, the ABCAT® functions as a mechanical filter for particulates. However less components are catalytically cracked. Also, the catalyst can not burn itself clean that well.
- The ABCAT® should not be exposed to temperatures of more than 700°C. Flames may not reach the catalyst. The temperature can be monitored with a bi-metal insert thermometer.
- The ABCAT® can get covered with soot during the lighting phase, or when the flue gas temperature drops. This soot is cracked and burnt when the ABCAT® reaches its operational temperature. From this temperature upwards the catalyst is self-cleaning for soot and other carbon-containing components.
- A part of the incombustible (mineral) components remain in the ABCAT®. A part of this ash can fall below the ABCAT®.
- The ABCAT® needs to cleaned periodically to remove the ash that remains inside the module. When the ABCAT® regularly reaches its operating temperature, this ash is mainly mineral ash. This ash can also be found on the bottom of the stove. To clean the ABCAT® it is taken out of the stove pipe. The catalyst is then rinsed with warm or hot water. When the catalyst is dry again it can be reinserted in the stove pipe.

The frequency of cleaning depends on many aspects, such as the use of the stove, the type of wood and the stove- and chimney design. Cleaning should at least be done when ash is removed from the stove. It is recommended to inspect and clean the ABCAT® regularly after installation. Based in the amount of ash that is removed from the module, the cleaning frequency for the specific situation can be assessed.

6.6 ABCAT® operation

With the handle the ABCAT® can be rotated. One side of the handle has a dimple. With this dimple the 'service' and 'bypass' position can be identified.

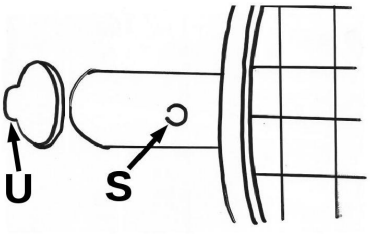


Bypass / Service position *Active position*

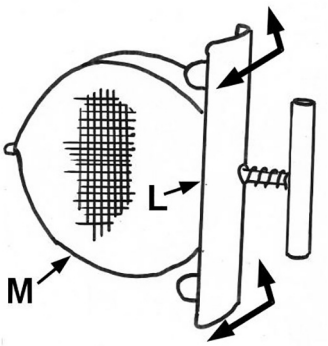
Bypass: In this position the ABCAT® is OFF. Only open the stove door when the ABCAT® is in this position. The bypass position can also be used if there is still little draft when the stove is started.
Service: In this position the ABCAT® can be removed for cleaning.
Active: In this position the ABCAT® is ON.

The ABCAT® is rotated into the bypass position before the stove door is opened. The ABCAT® is rotated into the active position after the door of the stove is closed. The ABCAT® can be rotated into the active position when, after top down lighting the fire, the stove door is closed. This way the ABCAT® heats up together with the stove and flue and starts to work as soon as possible.

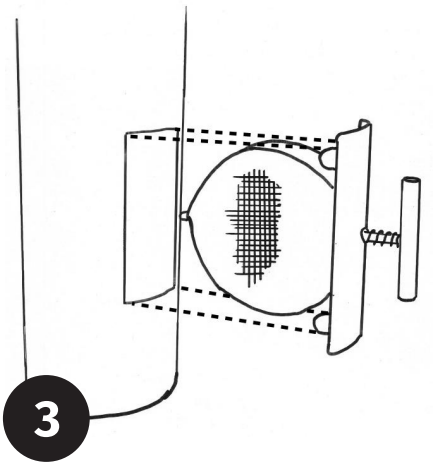
Reinserting the ABCAT®:



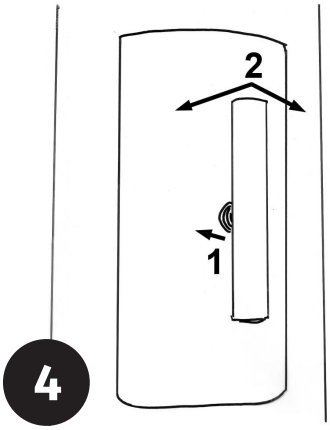
1 Ensure that the pin (S) fits in the opening (U) in the back of the stovepipe.



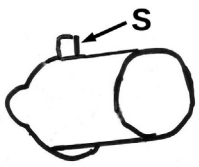
2 Position the hatch (L) straight in regard to the module (M).



3 Carefully slide the module into the stovepipe and steer the lips to the corners of the opening.



4 Push against the pressure of the spring (1), then turn the handle (2).



5 Check if the pin (S) is visible on the back of the stovepipe.

6.7 Warranty and replacing module

The warranty on the construction of the ABCAT® is 2 years. The functionality of the catalytic converter is guaranteed upon delivery, however, since the lifetime fully depends on the use of the catalyst, no warranty can be given on the catalytic converter itself. With good use and respect for the user conditions, the catalyst will last many thousand hours. The lifetime of the catalyst strongly depends on the combustion quality and the wood smoke temperature. Contaminated fuel and catalyst temperatures over 700°C have a negative impact on catalyst lifetime.

An indication that the module needs replacement, is when the ABCAT® is not self-cleaning any more although the temperature is sufficient and all previously mentioned conditions are met. An additional indicator is when the metal chips inside the module have become rusty due to overheating or bad fuel. In these cases the ABCAT® module can be replaced separately.

7. BURNING RIGHT

IMPORTANT: The better a stove burns, the more efficiency there is for the user and the less potential nuisance there is for neighbors. A real win-win situation!

Guidelines for wood burning:

a. The stove should only be fired when there is sufficient chimney draft. The draft ensures that there is a supply of combustion air to the stove ***and*** that wood smoke is removed. Aside from the design and settings of the stove and the chimney, weather conditions play an important role in the generation of chimney draft. In conditions with fog or high air humidity combined with little or no wind and high outside temperatures, a wood stove should not be used.

b. The pieces of fire wood should not be too big and have to be split. The split pieces should be stacked loosely in the combustion chamber to ensure a good flow of combustion air trough the pieces of wood. Bear in mind that it is not the wood itself that burns, but rather the wood gas. The combustion air has to be able to reach this wood gas from all sides.

c. The supply of combustion air should not be cut off (too much). Suffocating the fire leads to a significantly increased emission of unburnt components. The heat demand and output should be controlled with the amount of fuel that is added, not with the supply of combustion air. In other words, when the room gets too warm, less wood should be added to the fire. Also a window or door can be opened for cool air but most definitely the air supply to the stove should not be closed!

A lot of wood fired stoves with a heat exchanger for the production of hot water or hot air have a thermostatic or Lambda controlled supply of combustion air. This control monitors the stove temperature and oxygen level in the wood smoke and reduces the amount of combustion air to the fire when the heat demand is lowered. However, the wood in the stove remains hot and keeps on producing wood gas. An oxygen deficiency is created, which leads to a highly increased emission. This can cause serious smoke and odor nuisance. The best way to use this type of stove is to ensure that they can always lose their heat to a buffer, for example for hot water.
With heat exchanger stoves that use wood chips or pellets as fuel, the supply of fuel is stopped when there is no demand for heat. As a result the fire extinguishes and no more wood gas is produced.