

# Product information ABCAT<sup>®</sup> wood smoke filter

Summary specifications ABCAT <sup>®</sup> wood smoke filter	
Application	Wood fired stoves
Applied technique	Full metal palladium and platinum catalytic converter
Functioning based on	Catalytic oxidation and mechanical filtering
Oxidation/reduction of emission	Hydrocarbons, CO, PM, odor
Location	Directly after wood stove exit
Orientation	Horizontal, Vertical and position in between
Operational temperature catalytic converter	From 100°C, >350°C optimal
Maximum temperature catalytic converter	700°C
Allowed fuel	Clean fire wood with max. 20% moisture
Reduction PM emission (mainly PM <sub>2.5</sub> )	Up to 95%
Reduction PAHC emission	Up to 90%
Reduction CO emission	Up to 65%
Reduction hydrocarbons	Up to 90%
Flow resistance at 0,5 - 1m/s	Bypass 0-1 Pa, operational 2-5 Pa
Material	Stainless steel

## General

The ABCAT<sup>®</sup> has been developed to reduce the emission of wood smoke from chimneys of wood burning stoves. Most attention has gone to reducing the odor of wood smoke. The ABCAT<sup>®</sup> is installed directly after the stove, as first stove pipe segment.

The ABCAT<sup>®</sup> contains a precious metal catalyst and is completely constructed from stainless steel. The ABCAT<sup>®</sup> is very robust and the operation and maintenance are very simple.

## Functioning

The filter element of the ABCAT<sup>®</sup> is a mixed bed 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, which give the color and odor to the wood smoke. After the cracking of components, the separate parts are burnt without flames in a process called catalytic oxidation. 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 (residual) oxygen from the wood smoke to crack and oxidize (burn) chemical components. Starting at temperatures of just 100°C, components such as CO are oxidized. From 200°C onwards amongst others the VOC benzene is cracked. To convert long-chained, tar-forming components (including odorous ones) a catalyst temperature of 300 – 350°C is required. For this reason the ABCAT is installed directly after the stove. In this process of catalytic oxidation, heat is generated. It is a so called exothermic process. At catalyst temperatures over 300°C the catalyst is self-cleaning for soot and tar-forming components. The temperature in the catalyst can increase by several tens of degrees. This energy is used by the catalyst itself. There is no significant temperature difference of the smoke before and after the catalyst.

## Properties and performance

When the temperature of the catalyst increases after igniting the stove, first the least stable components like CO are cracked and oxidized. This process starts at around 100°C. During the further heating from 100°C to 300 – 350°C increasingly difficult components are rendered harmless. From 300°C more stable components are cracked. This includes for example tar-forming, long-chained hydrocarbons such as PAH's. These PAH's can have a strong odor and are potentially harmful to health and environment. From this temperature onwards the ABCAT® is also self cleaning for for example soot and tar which has been filtered out during the starting phase.

After the cracking of components, the separate parts are burnt without flames in the process called catalytic oxidation. The required oxygen is taken from the wood smoke. When the catalyst functions optimally, called a total-oxidation, only color- and odorless water vapor and CO<sub>2</sub> are emitted. The CO<sub>2</sub> can be absorbed by plants and trees and remains in the so called short-carbon-cycle without contributing negatively to the greenhouse effect.

Because of the construction of the catalyst it, next to the catalytic function, also has a mechanical filtering function for particulates in wood smoke. A part of the (mineral) fly ash from the stove is trapped in the catalyst. The mineral fly ash can not burn in the stove and will also not burn in the ABCAT®. In use, this mineral ash slowly covers the catalytic surface. This surface needs to be free so that it can react with components from the wood smoke. Therefore the ABCAT® needs to be rinsed with (warm) water regularly.

From test it has shown that the catalyst mainly cracks the smallest particulate fraction (PM<sub>2.5</sub>). This fraction is the most problematic to our health since these particulates can penetrate very deep into our lungs.

The ABCAT® functions at its best when applied to the flue gas resulting from a proper combustion. Therefore it is recommended to use the ABCAT®, in addition to the instructions from the ABCAT® handbook, in combination with a modern stove that meets the standards of EcoDesign 2022 or similar.

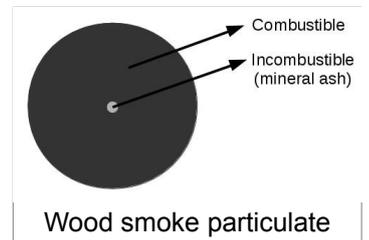
### What are particulates and what happens to them?

Particulate matter consists of liquid and solid particles. Liquid particles are very finely spread droplets (aerosols) of gaseous components which have condensed as a result of cooling down. These can be alcohol-components or hydrocarbons such as PAH's. The solid particles can be made up of wood dust, soot (carbon) and inert mineral inorganic ash.

When 1kg air-dry beech (15% moisture content) is completely burnt in a laboratory oven, approximately 5 grams of mineral ash remains. In a situation with a stove and a chimney a part of this mineral ash will remain in the stove as bottom ash and a part will be emitted trough the chimney as fly ash.

When wood smoke cools down in the chimney, a growing amount of gaseous components – such as water vapor, benzene and PAH's – condensates on the mineral fly ash. The condensate attaches to the particles which grow as a result. In the image a typical wood smoke particulate is depicted.

The taller the chimney and the more cooling down, the bigger the particulates can grow. That is, as long as they do not stick to the chimney wall as tar. An important portion of tar are harmful PAH's.



Because of the condensation of gaseous components, the composition of particulates directly after the stove is very different from the composition of particulates just before exiting the chimney where the smoke is significantly cooler. The wood smoke near the end of the chimney contains more particulate matter than the smoke directly after the stove. The particulates give color to the smoke and also contribute to the odor. Particulate matter from wood fired stoves consists of mainly incompletely combusted organic components and to a smaller extent mineral ash.

The ABCAT® treats the wood smoke directly after the stove. Solid, organic components such as soot and components which could condensate higher up in the chimney are cracked and oxidized close to the source. Incombustible components such as fly ash, on which cooled down gaseous components could condensate, partly remain in the ABCAT®. Because of this the ABCAT® can, depending on the type of fuel and stove and the catalyst temperature, reduce the emission of organic and inorganic components to up to 90%.

### What happens to the odor of the wood smoke?

Wood smoke consists of 70 - 80 volume% nitrogen, followed by about 10 – 20% residual oxygen, then several percent CO<sub>2</sub>, water vapor (from the 15% moisture from wood, from the combustion air and as a product of combustion), incompletely combusted components, carbon, tar droplets, ash, sulfur dioxide, NO<sub>x</sub>, etc. The components in wood smoke which can have an intensive odor and have a negative impact on health only account for 1 or 2% of the wood smoke volume. The odorous and harmful components belong to the groups identified below. Within these groups there are about 500 different separate components.

- several hydrocarbons, mostly polycyclical
- aldehydes, for example acetaldehyde (ethanal), propionaldehyde (propanal), formaldehyde and others
- organic acids including formic acid, acetic acid, propionic acid and others
- condensed aromatics
- styrene (ethenylbenzene)
- phenol (hydroxybenzene)
- others components: guaiacol, ethylguaiacol, furfuryl alcohol

Since the ABCAT® can catalytically oxidize a large part of these components, the odor of the wood smoke that can be detected from the chimney cowl is greatly reduced, as are the harmful components. When the ABCAT® functions optimally the odor is mainly neutralized. However there are great differences in type of fire wood, stove design, operation, weather conditions, etc which have a great impact on the odor of the wood smoke. For the ABCAT® to function optimally, and to reduce the odor significantly, all things before the ABCAT® have to be all right. The ABCAT® is not a tool to compensate an inferior installation of poor operation!

### Impact on chimney draft

The flow resistance or pressure drop of the ABCAT® in operation is 2 – 5 Pascal (0,02 - 0,05 mBar) at a flow rate of 0,5 – 1 m/s. This flow rate is common for wood burning stoves with a suitable chimney, fired on their respective heat output. The minimal chimney draft required for a wood stove to burn properly is 12 Pascal. This is also the chimney draft used for testing and certifying wood burning stoves. With this draft the flow resistance of the ABCAT® is easily overcome. A well designed and constructed, warm chimney easily produces more than 20 Pascal when the stove is burning well.

### Models

The ABCAT® comes standard in a stove pipe segment with a length of 300/330, 500 or 1.000mm. The ABCAT® is available for chimneys with diameters of 125, 130, 150, 180 and 200mm. The segment with the ABCAT® can be installed in a standard chimney without further modifications. The segment does not have a necking. When needed, an adapter is available for the different diameters.

The stovepipe is constructed from stainless steel. The segments can be connected to different types of chimney material.

The standard ABCAT® comes in a blank (unpainted) stovepipe segment.

Optionally a bi-metal insert thermometer can be installed (not included with the ABCAT®). This thermometer has a clear analog dial and a range up to 500°C.



With this thermometer the temperature of the wood smoke near the ABCAT® can be monitored. It is highly recommended to install this thermometer with the ABCAT® since it provides important information about the burning conditions and proper use of the ABCAT®.

## Installation

To install the ABCAT®, the first chimney pipe segment behind or on top of the wood stove is replaced with the ABCAT® segment. The ABCAT® segment is reversible and does not need to be installed in a certain gas flow direction. The ABCAT® can be installed vertically, horizontally or in any position in between.

The design and the use of the wood stove and the installation of the ABCAT® have to make sure that there can not be any contact between the flames and the catalytic converter. Flames can reach very high temperatures and damage the catalytic active surface permanently. When the catalyst is exposed to temperatures over 700°C, the catalyst can be damaged permanently. When the optional thermometer is installed, the temperature can be monitored. Aside from damaging the catalyst, a very high wood smoke temperature means a large loss of energy, lower efficiency of the wood stove and excessive use of fire wood. A very low wood smoke temperature on the other hand results in reduced chimney draft, poor combustion and high emission.

The ABCAT® has to be easily accessible for operation and maintenance.

## Operation of the ABCAT®

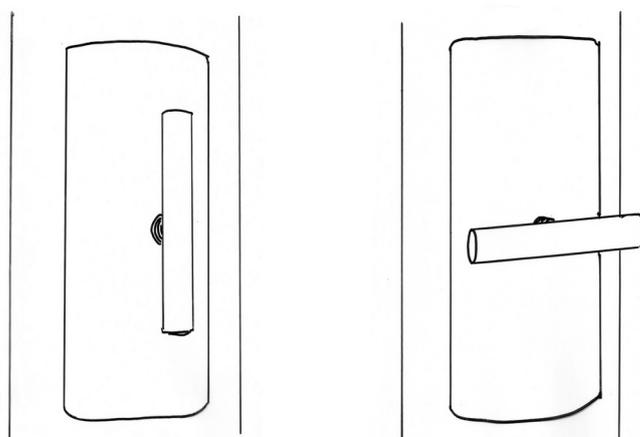
One side of the handle has a dimple. With this dimple the 'service' and 'bypass' position can be identified.

**Bypass:** In this position the ABCAT® is OFF. Only open the door to the stove when the ABCAT® is in this position. The bypass position can also be used when during the starting phase there is insufficient chimney draft.

**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 door of the stove 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 already starts to work.



**Bypass / service position**

**Active position**

The catalyst collects mineral ash. This ash need to be removed periodically from the catalyst to clear the catalytic active surface. Lack of cleaning will result in a (temporary) reduction of catalytic efficiency. The ABCAT® is cleaned by rising with (warm) water.

The frequency depends on different aspects. Clean the ABCAT® at least when the ash tray is emptied. More frequent cleaning is recommended for an optimal use of the ABCAT®.

The ash mainly contains mineral components such as potassium- and sodium salt and iron- and silicon oxide (sand) and is not harmful to the environment. If the ABCAT® contains lose black remains of soot, tar of creosote then this should not be flushed but rather collected and be disposed of with the household trash. The catalyst is self cleaning for components such as soot and tar. However, if these components are collected in the ABCAT® (during start up for instance) they will be cracked and oxidized when the catalyst reaches the operational temperature.

## **Warranty and lifetime**

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 burning hours. The lifetime of the catalyst strongly depends on the combustion quality and the wood smoke temperature.

Normal and responsible use means:

- fire wood is used that is suitable for use in an wood burning stove, meaning untreated wood and preferably types of wood that do not produce much odor. Please see the table in the ABCAT® handbook
- air dry wood with a moisture content of max. 20% and a circumference of max. 30 cm is used. Wood with mold also contains spores. This means there is a micro-bacterial break down as a result of poor drying conditions. Spores that are released can be harmful to health upon inhalation. Moldy wood usually also has a high moisture content making it unsuitable to fire
- the catalyst regularly reaches an operational temperature of 350°C
- the temperature of the catalyst does not exceed 700°C
- a catalyst that is still hot is not exposed to water of any other cooling liquid or gas. This exposure could lead to so called inter-crystalline corrosion in the catalyst, permanently damaging the catalyst
- the catalyst is not cleaned using acidic, salt of strong basic liquids. Cleaning can be done with cold, warm or hot water with optionally some added dish washing detergent. Sodium and chlorine containing agents can not be used

Please read the ABCAT® handbook for more information about the correct use of the wood burning stove in combination with the ABCAT®.