

Working Principle of the Zielonka-Geruchskiller [*Zielonka Odor Killer*] (Stainless Steel)

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Chemistry of Odorous Substances

Components of odor-producing substances include hydrogen sulfide, thiols, thioethers, ammonia, amines and butyric acid and butyric acid derivatives. Hydrogen sulfide, thiols and thioethers contain sulfur that is partially negatively charged. This property is also called nucleophilic. In ammonia and amines, this function is performed by nitrogen. Compounds containing nucleophilic sulfur or ammonia are generally found to be extremely foul-smelling. These foul-smelling substances are frequently decomposition products of biochemical processes controlled by microorganisms. Perfumes and other pleasant-smelling substances are usually members of the group of ketones and aldehydes.

Onions and garlic generate intense odors that are also caused by a group of sulfur compounds. Onions and garlic release propanethiol S oxide, which has an intense smell and reacts with water to form sulfuric acid that then induces tears and is an eye irritant.

Mechanism of Odor Absorption onto Stainless Steel.

The effect of odor absorption using stainless steel is a known phenomenon and has been experimentally confirmed. For example, it is generally known that stainless steel knives have a deodorizing effect on garlic and onion odors. However, there is still no scientific evidence as to the mechanism of the odor absorbing effect of stainless steels.

It has been found that the effect depends very much on the surface of the stainless steel. A micro-structured surface is very important for an effective absorption of odor. In addition, the presence of water molecules is required in order to achieve measurable odor absorption.

In principle, there are two basic mechanisms thought to be responsible for the working principle of stainless steel odor absorbers:

1. Catalytically induced oxidation of the odorous molecules at the stainless steel surface
2. Adsorption of the odorous molecules at the stainless steel surface

These mechanisms are explained below:

As to 1.

The fact that a specially produced microstructural or finely structured surface is of essential importance for the odor absorption in stainless steel suggests that such a stainless steel surface has a higher reactivity and thus special catalytic properties. It is a well known fact that nanocrystalline materials made of crystallites in the 1-10 nm size range have an extremely fine-grained structure. These materials are characterized by numerous atoms with an unsaturated coordination number at the metal surface. This means that regions of highly reactive catalytic centers form on the metal surface, said regions being able to initiate certain chemical reactions.

Special metal catalysts have been developed for oxidation reactions whose surface structures decidedly influence the effectiveness [of the catalysts]. The development of a catalyst from nanostructured gold on an iron oxide surface at the Osaka National Research Institute in Japan is one example of the development of an odor absorber. This absorber is based on the catalytically influenced oxidation of sulfur and nitrogen compounds to form neutral smelling products.

It is obvious to conclude that the structured stainless steel surface has a similar catalytic effect regarding the oxidation of the odorous molecules. The active metal

surface first binds the odorous molecules. Then, through electronic effects at the metal surface, the activation energy required for the oxidation reaction is lowered so that the oxidation processes can proceed. The resultant products are not gaseous and are water soluble. They can be washed off of the surface with water and do not escape into the room or into the environment.

As to 2.

There are different kinds of stainless steels that differ in their alloying components and crystal structure. The three main types are austenitic, ferritic and martensitic stainless steel. What is essential to odor absorption is the chemical composition, i.e. the alloying components are responsible for the binding of the odorous molecules. In addition to the main component iron, stainless steel can consist of carbon, manganese, phosphorus, silicon, chromium, nickel and molybdenum, for example. Iron, manganese and molybdenum have a high affinity for sulfur. This means that at least those odorous molecules containing nucleophilic sulfur are bound or adsorbed onto stainless steel. This binding causes the odorous molecules to gradually be eliminated from the surrounding air, thus reducing the concentration of the molecules. At a certain threshold characteristic of each odorous molecule, the odor is then no longer detectable. The structuring of the stainless steel surface has the effect of increasing the surface area by many times by means of micro- or nanopores and thus increases the adsorption effect. The presence of water molecules at the stainless steel surface results in a hydration of the bound odorous molecules and presumably to an oxidation to form sulfur-oxygen acids that no longer exist in gaseous form at room temperature. An analogous mechanism can be formulated for nitrogenous odorous molecules and for perfumes made from aldehydes and ketones.

Summary

Proven scientific evidence on the exact mechanism of odor absorption on specific stainless steel surfaces does not yet exist, although the effect exists without a doubt. As discussed here, odorous molecules are either chemically bound or they are

chemically reacted through oxidation after they are bound. Which of the two mechanisms dominates cannot be answered yet today.