SANUVOX

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About PCO : Photo Catalytic Oxidation

Common Titanium oxide base catalyst: TiO_2

In chemistry, **PCO** is the acceleration of a photoreaction in the presence of a catalyst. In catalyzed photolysis, light is absorbed by an adsorbed substrate. The photocatalytic activity depends on the ability of the catalyst to create electron–hole pairs, which generate free radicals (hydroxyl radicals: OH) able to undergo oxidation reactions. Its comprehension has been made possible ever since the discovery of water electrolysis by means of the titanium dioxide. Commercial application of the process is called Advanced Oxidation Process (AOP) and is used for water treatment.

Titanium dioxide, particularly in the anatase form, is a photocatalyst under ultraviolet light. Recently it has been found that titanium dioxide, when spiked with nitrogen ions, or doped with metal oxide like tungsten trioxide, is also a photocatalyst under visible and UV light. The strong oxidative potential of the positive holes oxidizes water to create hydroxyl radicals. It can also oxidize oxygen or organic materials directly. Titanium dioxide is thus added to paints, cements, windows, tiles, or other products for sterilizing, deodorizing and anti-fouling properties and is also used as a hydrolysis catalyst.

Although this technology looks perfectly transposable to air, there is one main practical caveat that recently came to light: the titanium oxide is being “poisoned” by silica and its useful service life is severely impaired. After some longer time experience of this technology in air, it was observed that the PCO would gradually decay and lose most of its oxidative potential within a year or less.

The effect of silica as a titanium oxide neutralizer is well known in the sunscreen industry. Every sunscreen with a physical blocker contains titanium dioxide because of its strong UV light absorbing capabilities, thus preventing UV from reaching the skin. Sunscreens designed for infants or people with sensitive skin are often based on titanium dioxide and/or zinc oxide, as these mineral UV blockers are less likely to cause skin irritation than chemical UV absorber ingredients, such as avobenzone.

However, to avoid the creation of carcinogenic radicals on the skin due to the activity of photo catalytic reaction, the titanium dioxide particles used in sunscreens are intentionally coated with silica. The addition of silica effectively neutralizes the photo catalytic properties of the titanium oxide, making the sunscreen harmless.

Because silica is commonly found in household applications such as caulking and many other materials, the PCO titanium oxide is contaminated with silica and will lose half of its activity within three months. This means that after 6 month, it will be down to 50% efficiency and after 9 months, down to 25% efficient and after a year, down to 12.5% only. It will then cease to provide adequate performance as an air purification device. This is the main reason why serious companies are now taking a step back and even walking away from the marvelous promises of common titanium oxide based PCO as a solution for odor removal.

New Cobalt Photocatalytic Oxidation (Co-PCO)

Using UV light to achieve clean air and water resources through photocatalytic oxidation is a goal of scientist worldwide (1,2,3) over the last two decades. Photocatalysis is a widely generic term that applies to chemical oxidation reaction enabled by photon activated catalyst, commonly called PCO in the air purification industry.

PCO catalyst consists of a metal oxide semiconductor, usually titanium oxide (TiO_2), with a band gap energy that allows the absorption of ultraviolet photons to generate electron hole pairs called “active sites” that can initiate the chemical reaction. For titanium oxide PCO, the energy band gap is centered on 360 nm photons, which is in the middle of the UV-A range (315-400 nm). This is quite far away from the UV-C range of common germicidal lamps emitting most of their photon energy at 254 nm wavelength and as such partially explains the rather deceiving efficiency of current titanium oxide based PCO air purifiers using low pressure mercury lamps. This low efficiency is mainly responsible for hazardous by-product formation such as formaldehyde. Another important barrier to the implementation of actual PCO is its short lifetime due to silica poisoning of the catalyst. Silica which is the main constituent of common sand is omnipresent in our daily environment. Siloxanes have been identified as the root cause of current PCO deactivation (4). As deactivation reduces the number of active sites available, incomplete oxidation becomes prevalent, promoting the production of by-products.

The fundamental effect of the addition of cobalt oxide is to shift the energy band gap of the catalyst toward higher energy photons closer to the 254 nm photons emitted by low pressure mercury lamps. With a capacity to absorb at higher energy, the cobalt enhanced catalyst provides enough photocatalytic activity to completely oxidize household VOCs (5,6) and avoid the transient formation of formaldehyde, acetaldehyde, and other incompletely oxidized by-product. It is worth noting that the higher energy active band gap of the Cobalt catalyst is much wider than the actual titanium oxide and was found to be almost insensitive to silica poisoning. Actual testing has shown no significant decline in the Cobalt catalyst activity after a full year in service.

References

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