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A Potent Gas: Ozone

It was a recording-breaking event when the new celllulose plant of Votorantim Celulose e Papel featuring the world's biggest ozone generator went on stream in Brazil. Produced by Wedeco Environmental Technologies, the generator boasts another superlative: it is equipped with an impressive 63,000 "Duran" glass tubes from Schott-Rohrglas.

"My friends always suspect that I am doing something bad," claims Ralf Fiekens. The process engineer at Wedeco Environmental Technologies in Herford is used to people's reaction when he tells them he builds ozone generators. Ozone? Everyone is aware of the problems with the ozone hole and ozone warnings. It irritates Fiekens that the gas that is the focal point of his work has such a bad reputation.

The ozone generators are installed in large-capacity containers.

Mostly only experts know that ozone is a tried and tested disinfectant. After elementary fluorine, ozone is the strongest oxidant known to chemistry. The oxidation of organic substances is the important step in disinfecting water, and also in bleaching processes. This method was used for the first time in 1903 to disinfect the water system in Paris. For a long time the treatment of potable water was practically the only application of ozone – and even so, it was not widely used.

The range of applications has expanded in more recent years. Today, the three-atom variation of oxygen purifies highly polluted industrial effluent, and it is used to bleach, for example, cellulose, the raw material in paper production. If left unbleached, the paper would retain the color of lignin, a constituent of wood.

Always produced on site

For those who use ozone there is, however, one special feature. Unlike hydrogen or argon, ozone is not a gas that can be purchased in a bottle or a tank. Because of its instability, it cannot be stored and always has to be produced directly at the site of its application. This is the job of ozone generators.

The Brazilian paper and cellulose manufacturer, "Votorantim Celulose e Papel" (VCP), uses ozone to bleach its cellulose. VCP increased its production capacity at the end of October 2002 and started up a new factory. For this purpose, the Brazilian company had ordered an ozone system from Wedeco, which was delivered in the late summer of 2002. Their requirements exceeded the capabilities of a standard ozone system: the generator had to produce 510 kilograms of ozone per hour – nearly 20 percent more than the biggest unit used by the cellulose industry up to now anywhere in the world.

A silent discharge

The most efficient method to produce ozone on an industrial scale is silent electric discharge in oxygen. Manufacturing equipment for the production of ozone is Wedeco's daily business. But the unique feature of the order from Brazil was the size of the unit. While most of the units sold so far produce up to 13 kilograms of ozone per hour, the system designated for the city of Jacareí near São Paulo was to manufacture nearly 40 times that amount. One year of intensive project work was necessary to plan and construct the unit.

No matter how much ozone a unit is to produce per hour, the primary component for ozone production is always the same size: a borosilicate glass tube one and a half meters long with a diameter of 11.5 millimeters. An equally long metal rod runs through the interior. There is one chamber between this rod and the inner wall of the glass tube, and

A primary component of ozone generators are the glass tubes, each of which contains a metal rod. The glass tubes are enclosed by stainless steel sheaths. Ozone is produced from pure oxygen by applying electric voltage to the chambers between the metal rod and the metal sheathing.

Committed to protecting the environment: Wedeco Environmental Technologies

Wedeco was founded in 1975 and has been involved in environmental technologies from the very beginning. Its first field was the UV treatment of water. In the late 1980s business expanded to include ozone generators. This business is handled by the spin-off company, Wedeco Environmental Technologies, a wholly owned subsidiary of Wedeco Water Technology AG, which is still involved in UV technology.

More than 4,000 ozone oxidation systems have been delivered since 1990. The company is thus one of the most experienced suppliers of systems based on ozone technology. Some 250 employees generated sales of 35.8 million euros in 2001. Sales of 49 million euros are expected for the year 2002.

Three separate generators each with some 21,000 “Duran” glass tubes – 10,324 at each end – were installed in the world’s largest ozone production system at VCP in Brazil. The outer and inner diameters of the special glass tubing required for the construction of the electrodes have an extremely narrow range of permissible variation.

Ozone

Is it good or bad?

Ozone is indeed a confusing subject. If it is lacking in the upper atmosphere, we say there is an ozone hole, which is cause for concern. We hear the ozone warnings when too much ozone is produced on hot summer days and the ozone levels in cities exceed certain limits. Like carbon dioxide and methane, ozone is a so-called greenhouse gas, which means it contributes to the warming of the Earth's atmosphere. On the other hand, many experts say ozone is friendlier to the environment than chlorine or chlorine dioxide when it comes to water treatment. So how can a non-expert be expected to make sense of all this?

Quite simple: ozone is good and important when it is more than ten kilometers above our heads – in the stratosphere. Here it acts as a barrier against harmful ultraviolet solar radiation. But if the content is too high in the atmosphere closer to the Earth, it is indeed relevant to the climate – and also toxic.

Bleaching cellulose or disinfecting potable water is not a problem because the ozone is produced specifically for these purposes. In addition, it is used in closed systems, and excess gas is immediately dissipated after application. This is considered environmentally acceptable since all substances created during the application itself or when the remaining ozone is dissipated are safe.

A variety of applications

Besides its application in paper production, ozone technology is also used in a variety of other ways by communities and industry:

- to treat potable water in waterworks, in combination with ultraviolet technology to decompose drug residues and hormones in effluent by oxidation,
- to eliminate pollutants in swimming pool water,
- to eliminate odors from flue gases,
- to sterilize softdrink bottles,
- to improve the adhesive and bonding strength of plastic surfaces,
- to decompose germs and pollutants on fish farms.

another between the outer wall of the glass tube and the stainless steel outer covering around the glass tube.

Air or pure oxygen is fed into these two chambers. At the same time a very high voltage is applied between the metal rod and the metal covering, thus creating a strong electric field similar to the one between two capacitor plates. When exposed to the electric field, some of the oxygen molecules in the input gas break down into two oxygen atoms. These single atoms attach themselves to free oxygen molecules and form ozone.

If pure oxygen is used, the ozone output is higher than with simple air, which usually has an oxygen content of only about 20 percent. However, pure oxygen as a starting material must first be produced or bought, whereas air is freely available.

Glass tubes prevent short circuits

The fact that such high voltage does not cause a short circuit is due to the glass tubing. Borosilicate glass is an effective insulator that prevents any charge transfer from the metal rod to the metal coveriing. "That is the reason why we use this glass for the construction of our electrodes," says Ralf Fiekens about the "Duran" glass tubing that Wedeco has been purchasing from Schott for years.

2002 has been a particularly good year. The application of ozone has been booming, as the eight industrial-scale ozone systems in Wedeco's order books prove. Some 63,000 glass tubes alone were required for the biggest generator produced so far, the one in Brazil. There are obvious reasons for this impressive number: the more ozone to be produced, the greater the number of electrodes arranged in parallel lines. In the case of VCP, this means three separate generators, each with nearly 21,000 electrodes. In fact, Schott concluded a separate agreement with Wedeco for special service in connection with this order. "For this project, it was extremely important that the outer and inner diameters of the glass tubes were kept within a very narrow range of permissible variation," stresses Ralf Fiekens. Schott included the specially requested measurement of the inner diameter in the quality requirements for Wedeco's order, thus ensuring that all 63,000 tubes sent to Herford had the requested specifications.

Adding value

It appears there may be more big orders for the manufacturers of ozone generators in the future. Despite this boom in recent years – and not to mention all the advantages and ecological benefits compared with chlorine – ozone still only plays a minor role. Thus the potential is enormous. But even that is not enough for Ralp Fiekens and the Technical Director of Wedeco Environmental Technologies, Uwe Hofer. Hofer not only hopes to expand end-of-pipe applications, such as effluent treatment, potable water disinfection and cellulose bleaching. He also intends to penetrate the value-added chain with this potent gas and already has an example of how he plans to do it. "Tests with juice cartons have shown that the final polyethylene lamination of the aluminum coating is a better quality if you anodize the aluminum beforehand with ozone."

Ozone therefore appears to be a promising substance for the future. And who knows, perhaps Ralf Fiekens' friends will react differently some day. "What? You produce ozone? That's great!" ◂

Made in Brazil – VCP

VCP is one of the biggest producers of paper and cellulose in Brazil. With the start-up of the new plant in Jacareí, the annual capacity increased to 1.4 million metric tons of cellulose. In 2001 the company generated sales of $654 million. Forty percent of the production is exported to more than 50 countries around the world. VCP employs more than 3,700 people.