PCC-Technology – a new generation of ozone generating plants for the mineral and table water industry

Dipl.-Eng. Bernhard Baumgärtner

Mineral water is popular. The calorie-free beverage is appreciated by an increasing number of people as a healthy alternative to alcoholic and sweet drinks. The majority of the consumers of mineral water prefers a healthy living. In most cases mineral water comes up to these demanding expectations, since it is collected from deep soil layers (up to 1000 meters) after having passed different strata for some hundred or even thousand years. The consumption of mineral and table water showed a continuous increase during the last years. Especially in the range of “non-sparkling water“ and mixed drinks (table water with addition of aroma) the increasing rates are considerably higher than in the average of this branch in Germany.

Treatment of mineral water

Natural mineral water has to come from subterranean springs, it must be naturally clean and protected from man-made pollutants. Except for carbon dioxide no additives are permitted. Raw water low in oxygen can contain both iron-II and manganese-II or also hydrosulphide.

In contact with atmospheric oxygen an aesthetically bothering turbidity can occur after filling. This is the reason why it is allowed to eliminate iron and manganese according to the German law for mineral– and table water.

„A natural mineral water as it is opting out from the spring may not undergo another treatment as the removal of unstable components like iron or sulphur, ...if necessary using an aeration…with a treatment using ozone loaded air (1)”.

For the removal of iron or manganese the use of air is a standard technology in drinking water treatment. The oxygen in the atmospheric air is mixed intensively with the water and the undesired substances are oxidised and eliminated with a sand filtration downstream.

This chemical oxidation process is rather slow. While the oxidation of iron is happening in neutral or weak alkaline area, the oxidation of manganese is working only in a stronger alkaline area.

The use of ozone for the removal of iron and manganese

The mutual removal of iron and managnese is only possible using ozone.

Even if in the raw water the manganese value is rather high it can be lowered under 0.05 ppm. In this case a two-stage filtration with sand and activated carbon is recommended.

The filtration over activated carbon will remove the pink permanganate (MnO_4^-), that might have occurred during oxidation. On the surface of the carbon filter it will be reduced to insoluble brownstone (manganese dioxide).

The theoretical ozone consumption is 0.44 ppm ozone for 1 ppm iron-II and 0.8 ppm ozone for 1 ppm manganese-II. An excess of 10% ozone makes sense.

The use of ozone for the treatment of bottled water

Table water (according to the German law classification) is an artificial manufactured water that may be produced by mixing mineral water, public drinking water, natural thermal water or sea water. The supplementary addition of mineral salts is allowed as well the transportation in containers or tank lorries.

Due to the intensive use of drinking water resources, especially when surface water is involved, a water treatment beyond the classical methods is necessary for the production of table water.

Organic substances need to be treated oxidative either until their complete removal or until they do not influence taste or odour of the product negatively. Ozone treatment of table water is gaining grounds especially due to that reason.

The outstanding oxidation performance of ozone is perfectly suitable not only for the removal of iron, manganese or sulphuric compounds, but especially for the removal of organic substances together with a subsequent filtration. Ozone itself is decomposing to oxygen, therefore no foreign substance is introduced in the water. The half-life time of ozone is between 3 – 10 minutes.

Another problematic area where the use of ozone can create a significant benefit is the filler. Glass bottles and even more the often used plastic bottles do cause a risk of microbiological contamination. After filtration - before the filling - ozone can be added to obtain a microbiological protection during the filling process.

Due to the short half-life time of ozone it is decomposing to oxygen. The customer receives a taste- and odour-free table water with an excellent shelf-life.

At a rinser ozone can be applied, too .

In the past ozone systems for the mineral or table water industry did cause a rather high investment and the installation was complicated. New ozone systems have been developed which meet the requirements of this industry very well.

New developments in the ozone generation - the PCC technology

The introduction of the PCC technology (primary current controlled) offers complete protection of the electric components (high-voltage transformer and power board), furthermore it allows a correct digital display of the ozone capacity in “grams/hour”. Therefore, any desired quantity of ozone between 3% and 100% of the nominal capacity can be reproducibly adjusted.

Up to now the only control method for ozone generating plants was adjusting the ozone capacity by means of varying the high-voltage at the generation module. This led to a break-down of the silent electric charge in the low–range area of the nominal capacity, and therefore reducing the adjusting range, as the silent electric discharge requires a certain minimum high-voltage.

When using the PCC technology the ozone quantity is adjusted via the variation of the primary current. This works well by means of the medium frequency technique as the primary current is linear with the electric resistance of the generating module and ozone quantity.

However, there is another advantage which is decisive in practice. If humid air penetrates the discharge gap due to an operating failure, the secondary and as a consequence also the primary current consumption increases. The PCC technology immediately reduces the primary current thus avoiding possible excessive damage to the ozone generator and electronics.

Integrated Air Treatment

A well operating air treatment is a prerequisite for the achievement of the ozone concentration in mineral water treatment. Otherwise the remaining humidity leads to the formation of nitrogen oxide gas and nitric acid. Not only the life time of the ozone generator will suffer but the mineral water may receive undesired impurities, too.

The build-in pressure swing dryer at the Ozonfilt OZVa (see picture No. 1) is very compact and has excellent drying features suitable for an environment with higher humidity than specified in the German standard for ozone generation systems DIN 19627: 60% humidity at 30°C ambient air temperature. This new generation of ozone system can operate uninterrupted at 85% humidity and 35°C, if the cooling water has a temperature of max. 30°C.

The dryer is connected to a compressor included in the standard scope of supply. The compressed air is first led to a fine filter and afterwards dried down to a dew point of –60°C with a molecular sieve (the DIN 19627 requires only –45%). The regeneration does not require heat.

After drying the air flow is measured with a digital sensor and this value is used in the microprocessor for the calculation of the display “Ozone g/h”.

Simple Installation

The biggest benefit of the Ozonfilt OZVa series is the simple installation. In the past injector with booster was the standard technology to mix and dissolve the ozone gas in water. Now, the water flow can be directly ozonated, at a system pressure of up to two bar using a high performance static mixer after the injection point of the ozone gas. To ensure a high transfer rate a variety of static mixers has been developed. The dissolving rate is above 90% at the nominal water flow and at 20°C water temperature. The standard material PVC is at the least possible cost but can be changed to stainless steel (316 Ti) to suit the requirements of the beverage industry.

Literature:

(1) quoted from: Guideline 96/70/EG or the European parliament, dd. 28th October 1996 changing the guideline 80/777/EWG for harmonizing the special provisions of law of the member states on the production and the trade with mineral water

Picture 1: New Ozone Generation System: Ozonfilt OZVa by ProMinent