

How to transport and wash 88,000 tons of apples a year?

In the Roen agricultural company, 450 cubic meters of water constantly circulate. An innovative ozone generator affords the company the ability to dispose of wastewater infrequently and to avoid burdensome tasks of periodic cleaning of the production lines.

Washing 88 tons of apples is all but a simple prospect, with which the Roen agricultural company, the cooperative of Caldaro (Bolzano Province) with its 700 Southern Tyrolean apple-growers has to deal daily. In this South Tyrol valley apples renowned worldwide are cultivated and packed. In fact, as cooperative president Harald Weis explains,

“We export two-thirds of our production to over 30 countries.” A choice of focusing on export, suggested as well by the progressive decline in Italian consumption, that stimulates growing attention to international markets. To be competitive, also in the face of rivalry from other countries, the growers have invested in the quality of their products and on the establishment of a cutting-edge

processing/preserving cluster. During harvest weeks, in fact, trucks and tractors loaded with apples shuttle back and forth between the orchards and the Caldaro facility, where the urgent tasks are to stock and sort the fruit that will arrive on our tables in the following months.

Processing is a particularly delicate prospect, in that it is necessary to transport and wash the apples, but also sort them based on color and weight, discarding those that are bruised. A process that, within the Roen agricultural company, has been completely automated. The automatic recognition system, in fact, photographs each single piece of fruit 60 times, then positions it, based on type and weight, in one of 55 processing flumes. While the manual activity takes place only at the moment of packing.

ECOLOGY AND SAVINGS

Besides correct sorting, Weis explains, accurate cleaning of the apples that, having been cultivated out in the open, may be dirty with soil, is fundamental. A situation conducive to the proliferation of micro-organisms and that, therefore, accelerates deterioration.

For this reason, as soon as the crates arrive at the facility, the fruit must be washed. A technically simple operation, in that the action of water is sufficient to remove matter deposited on the peel.

Moreover, the water, in which the apples float, provides transport, without the use of mechanical devices that could cause bruising, to the sorting and packing point. The quality of the water therefore plays a fundamental role in the process. As crates of apples arrive from the orchards, the water actually tends rapidly to become dirty. A condition that, as one might expect, renders more complex the subsequent cleaning operations. Besides any visible appearance, problems occur above all on a microscopic level, in that the presence of foreign matter fosters the proliferation of micro-organisms that, once deposited on the surface, may cause the fruit's rapid deterioration. Although washing operations don't employ chemical agents, the enormous quantities of water used alone constitute a significant environmental impact.

Soil and organic particles deposited on the peel, in fact, dissolve in the very water used for washing, increasing the concentration of suspended solids.

Although these are starches and sugars, the COD (chemical oxygen demand) load in the water increases progressively. Thus, to respect the limits on dumping into surface water, it would seem necessary continually to change the water. A choice that, as one might expect, would prove not to be very ecological, or economical due to the cost of resources.

THE CHOICE OF PURIFICATION

“For a company like ours – explains Weis – that survives on natural products and that, therefore, is particularly attentive to the environment, it's important to have a technical solution customized to resolve the issues in this area. Even considering our continual growth, thanks to the admission of new grower-members.” From here the investment, starting in previous years, in purification capable of treating the water so as to operate in “closed-circuit” mode, minimizing spills into surface water. It seems almost a given, therefore, to adopt a system based on traditional filtration and purification systems. A choice that, however, fell short. The total bacterial count, while respecting the legal limits, remained too high compared to the Roen agricultural company's requirements. A situation that frequently entailed the necessity of closing the plants in order to change the water used for washing and transport. No fewer than 450 cubic meters of water per single cleaning thus had to be removed and replaced into the cycle, with a significant



The use of ozone eliminates algae and bacteria without chemical additives or harmful residues

impact in terms of cost and production efficiency. Taking stock of this situation was, thus, onerous for the Roen agricultural company, constrained to interrupt its production lines for almost 50 days each year. Intolerable interruptions, above all during the six-month period from December to June, when sales reach their peak.

OZONE WASHES THE APPLES

In light of these difficulties and the prospective of further growth of the business, in 2016 the Roen agricultural company instigated a nationwide scouting effort to identify an efficient, environmentally-friendly solution. Among the proposals received was that of HSE Engineering & Consulting Srl, the South Tyrolean engineering organization specialized precisely in engineering and services for industry and the environment. An ideal situation for designing projects based on the most innovative technology. “Considering the limitations of a classic filtration system - explains HSE's sole administrator, Christian Laureanti – many propose the use of chemical additives such as hydrogen peroxide or hypochlorite. In terms of sheer numbers, such a solution would have reduced the bacterial count. The Roen agricultural company's leaders have however discarded these options, because the chemicals would have entered in contact with the apples, some of which are certified [organic].

Without neglecting the cost of the products used and the necessity to eliminate them prior to dumping the water.”

For this reason, HSE proposed a technology designed for drinking water and wastewater, but already tested with success in several food industries: ozone treatment. Ozone, in fact, has the advantage of disinfecting water without addition of chemicals, destroying all bacteria, viruses, and pathogens potentially present.

Ozone is a molecule found in nature that forms during thunderstorms, when lightning furrows the sky. In industry, ozone production is substantially similar, in that it's based on the generation of electrical shocks that, passing through a stream of air or oxygen, are capable of breaking down the diatomic molecules of the very oxygen, that then regroup in triatomic form precisely generating ozone molecules.

A molecule that is in any case unstable and, therefore, tends to decompose into the most innocuous diatomic form, without leaving behind any residues harmful to the environment or for food. We are therefore dealing with an ever more appreciated solution in the food sector that HSE has illustrated with success to the Roen agricultural company's leaders. Once the preliminary project was approved, HSE's designers grappled with the design and establishment of the treatment plant.



In Roen's plants 450 cubic meters of water constantly circulate



The effectiveness and efficiency of ozone treatment have been verified in the field after 6,000 hours of operation

An activity in which HSE was called upon to comply with a series of strict criteria defined by Weis himself. The president of the Roen agricultural company is in fact also an esteemed technician in the agricultural sector, with years of experience in all the activities connected with apple cultivation and processing.

Weis coordinated and assisted the designers of the plant for the treatment and reuse of processing water, in such a way as to evaluate all the specificities of apple processing and the resulting interactions with existing plant designs. His requirements, in fact, were decidedly strict: the plant had to guarantee absolute reliability, in that, during full production, any malfunction would risk interrupting production of a product prone to rotting.

“Even before sizing the components – explains Laureanti – we have, however, addressed strategic questions, such as the generation of the ozone itself and the positioning of the treatment plant.” Since the Caldaro facility had recently been expanded, the space dedicated to water treatment had to be minimal, also due to being positioned inside warehouses to avoid the effects of freezing. From here the choice not to purchase oxygen, but to use atmospheric air. A method that eliminates the risks and encumbrances of a storage facility. Ozone is thus directly produced by dry air, even if this entails a greater consumption of energy. “In reality – continues Weis – energy consumption, however important in every industry, in the production of ozone doesn’t represent a material limitation.

The installed plant, in fact, absorbs little more than 2.7 kWh, an irrelevant value percentage-wise, given the fact that each of the 17 pumps employed to move the water absorbs on average 40 kWh.” We are dealing with, therefore, a contained amount of energy consumption, added to a substantial reduction in construction and operating costs. A conventional sand and activated carbon filtration plant, though conferring minor efficiency, would in fact have had a 20% higher initial cost. To which would be added energy and maintenance costs fully five times higher.

Moreover, operating in settings where work is performed by groups of people conferred particular importance to safety criteria. All without forgetting the economic aspects, fundamental in a company marketing low-margin products.

THE BEAUTY OF OZONE

In the face of this challenge and such an innovative project, HSE had no doubts when choosing the key supplier in the marketplace and turned to Xylem Water Solutions, the multinational owner of the Wedeco brand: “Besides its leading products and 40 years of experience in the sector, Wedeco guarantees direct technical support in the form of a team of specialists in the sector, with whom we can evaluate each design and dimensional aspect.”

WE CAN DO BETTER

The energy saving, tested in the field, is truly remarkable. But HSE and Wedeco technicians, several months after putting the equipment into service and after having tested its reliability, are convinced they can further reduce costs. “As it was an innovative treatment in this sector – explains Laureanti – we had no certainty of a sufficiently effective response of the system.

So we chose to oversize the ozone contact system and make it redundant, providing two contact towers, each associated with a destroyer of residual ozone. All of which is served by an SMA series Wedeco generator, equipped with PLC and data exchange in Profinet. In practice – Laureanti continues – the equipment today is used at just 57% of its potential, but it guarantees us a margin of flexibility that Roen will be able to use in view of increased production.”

The progressive optimization of the treatment process, on which HSE and Wedeco technicians are still working, today ensures constant changing of the washing and transport water, implying continuous removal (and replacement) of 18 cubic meters of water per hour. In this way, the 450 daily cubic meters of water, used in the process of washing and transport, are constantly treated, reducing the bacterial load without the necessity to interrupt activities. The water is in fact treated within two contact towers of only 1,200 mm in diameter, thus minimizing the surface occupied. Such structures are developed vertically, with 4 meters of baffles, allowing the ozone microbubbles released on the bottom, to eliminate algae and bacteria while they rise up toward the surface.

The search for ideal solutions for food sector equipment involved close collaboration between HSE and Xylem technicians, but also Weis’s and the Roen agricultural company technical team’s constant monitoring. Xylem’s catalog, in fact, also proposes a complete range of Lowara brand handling pumps and Sanitaire innovative ceramic disc diffusors that, installed at the base of the contact towers, prevent the formation of deposits. All in the most varied range of sizes, always allowing for the choice of an optimal solution without compromise.

After treatment, purified water is stored in a hydropneumatic tank. The small amount of ozone not decomposed into oxygen accumulating in the headspace of the contact towers is destroyed via transiting a bed of catalytic material, which transforms the ozone molecules into oxygen at merely 40 °C. All this along with rigid control via a network of sensors capable of detecting any possible leakage of molecules potentially dangerous if inhaled.

THE APPLES LAST LONGER

Although the project was studied in the minutest detail, verification of its effectiveness was ascertained only at the end of the summer, at the height of the harvest season. During those weeks, the technicians of the companies involved along with those of the public agencies that financed part of the experimental project conducted a series of analyses on the water used and introduced into the production cycle.

The results were actually above expectations. In fact, although the oxidizing effects of ozonation were noted, after treatment some concerns remained regarding the quality of the water inside the equipment.

In contrast to what occurs in traditional systems, in fact, ozone treatment does not require complete emptying of the equipment, but instead a continuous reusing of the water itself.



The ozone treatment plant designed by HSE obviates the necessity of weekly emptying of the washing and processing equipment

For this reason, Weis and Laureanti introduced a sensor to monitor continuously the amount of ozone transferred to the treated water. Such information, sent to the master PLC, allows for the automatic management of ozone production, in function of actual purification needs, and to offset removal and replacement in order to maintain the required levels of water.

A substantial difference with respect to the old systems, in which the water is perfect at the start of the treatment cycle, but degrades progressively in quality until its substitution is complete. This confers a limitation that does not allow for removal of all bacteria present on apple peels and, therefore, accelerates the fruit’s deterioration.

“From an industrial point of view – explains Laureanti – the most tangible result is, after all, that linked to process efficiency. In the past, in fact, emptying the washing and transport flumes was a weekly occurrence that imposed a complete interruption of processing.

This meant, all things considered, the loss of almost 50 working days each year. Ozonation – Weis concludes – has drastically reduced this necessity, to the point at which the flumes are emptied only once a month to remove deposits accumulated on the bottom.”



HSE and Xylem technicians worked in close contact to identify the best solutions