

The use of ozone as a driver for economic and environmental sustainable development

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Abstract

Sustainability, as a scientific concept, is multidisciplinary and very wide topic. Sustainable development bases its strategies not simply on the concept of growth, but rather on that of optimisation, around three main principles: ecosystem integrity, economic efficiency and social equity. The purpose of this paper, after an introduction about the concept of sustainability in general and as a strategy for the enterprises, is to discuss the potential of the use of ozone in different field, as a source of sustainable development, according to two of those principles, *i.e.* economic and environmental. In the first part, the concept of sustainability will be investigated in deep, with a managerial point of view, while the second part of the work will briefly analyse the current state of the arts of the uses of ozone, with also some practical examples. Finally, the discussion will take care of the reasons why the use of ozone, in several fields, could be considered as a driver for sustainability.

Introduction

Sustainability and development meet and complement each

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other in the concept of *Sustainable Development*, which has been the subject of various interpretations over the last 20 years.

The most famous definition is that of the Bruntland Report:¹ “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Another *historical* definition is that formulated in 1991 in Munro:² “the satisfaction of the quality of life, keeping within the limits of the carrying capacity of the ecosystems that support us.” The two definitions together give a clear understanding of the concept of Sustainable Development as a benefit to people and ecosystems.

According to Bruntland’s definition, sustainability revolves around three fundamental components: economic, social and environmental sustainability, three interdependent and mutually reinforcing components of sustainable development, which can be represented by three distinct groups, whose intersection represents sustainable development itself.

The need to pursue sustainable development by business organisations leads to significant changes in business policies and practices. Companies are increasingly open to sustainability, developing values and increasing strategies and practices in the field, making them take on a significant role in all areas of management, from production (reducing, for example, environmental impact, increasing worker safety and product quality), to marketing and human resource management (management of career paths, training policies, management of redundancies, *etc.*) to financial aspects.

Furthermore, there is a growing awareness that the survival and future development of the planet but also of social organisations must be balanced by environmental impacts, social implications and the achievement of economic results. On the entrepreneurial organization front, the model of the Sustainable Corporation is affirmed.

Ozone is the most powerful disinfectant and clarifier that can be found in nature, capable of breaking down the large macromolecular components that are the basis of the vital integrity of bacterial cells, fungi, protozoa and viruses.

For this reason, disinfection is the basis of most of its industrial and agricultural applications, playing a decisive role in the purification of drinking water, wastewater treatment, sanitization of surfaces, tools and machinery, food preservation, environmentally sustainable and organic farming practices, prevention of biological and chemical risks, disinfection of public and private swimming pools, housing of mussels and fish and iron oxidation, phenols with magnesium subsequent filtration.³

The use of ozone in the sanitization and treatment of water brings a rapid disinfection by bacteria, viruses, does not involve any alteration of flavours and no production of odours and residues, is effective at low temperatures and wide pH range.

The importance of humidity in the antiseptic action of ozone has been recognised and numerous experiments have confirmed

that germs treated in a dry environment are practically unaffected and bactericidal action occurs only in the presence of water or humidity; for this reason, food production areas and ageing cells represent the ideal environment for the development of moulds, yeasts and bacterial charges, which can cause irreversible damage to products.

Given these properties of ozone, the purpose of the present paper is to analyse the state of the art of the use of ozone within agriculture and animal husbandry, in order to verify that this technique could be at the basis of a sustainable development for the enterprises using it, both under the economical point of view (financial, managerial and strategical) and under the environmental point of view.

Sustainability: scientific concepts and multidisciplinary topics

The concept of sustainability was originally coined in forestry, where it meant: "never collect more than the land can produce in a new growth." This showed a high concern and need to preserve natural resources for the future, two prerogatives that were already placed at the time by our Palaeolithic ancestors and early farmers, concerned that their prey could be extinguished and that the soil lost fertility.

When it comes to sustainability, it comes to what can be maintained over time, so any society considered unsustainable cannot be maintained for long and will cease to function at a specific time.

Over the years, sustainability has become an important subject of natural study for economists, since scarcity of resources has proved to be an interesting and central topic for the sad science; an example is the essay published by Thomas Robert Malthus in 1798, focused on the principle of population and its effects on the development of society.

In 1972, the Club of Rome, which in its role analyses the changes in contemporary society, devoted itself to the problems of scarcity and the limit of development, scientifically demonstrating the existence of an insurmountable limit to economic development because of the exhaustible resources, present in fixed quantities in nature; more specifically, the Club established that an excessive rate of population growth involves a clash with the limit of natural resources, available in finite quantities in nature and not incrementable.

This gives rise to the need to adopt sustainable development, a policy based on natural resources and sustainable limits to exploitation, so that the planet can benefit from constant economic growth without running the risk of depleting resources.

Sustainability as a policy concept became important for the first time on March 20, 1987, when Norwegian Premier Gro Harlem Brundtland, President of the World Commission on Environment and Development (WCED) established in 1983, presented the report *Our Common Future*, formulating the first guide for sustainable development, still valid today.

Brundtland¹ defined sustainable development as development that allows the present generation to meet its needs without compromising the ability of future generations to meet their own needs.

Therefore, environmental concerns are important, but the key issue is welfare, seen in a context of intergenerational equity.

We should therefore be concerned about the environment, not for its intrinsic value, but to preserve resources for our children.

This definition embodies awareness of the presence of non-unlimited natural resources and a call for responsibility and caution in their use, and sustainable development should therefore be

able to improve the quality of life or well-being over time.

According to Brundtland's definition, sustainability revolves around three fundamental components: economic, social and environmental sustainability, three interdependent and mutually reinforcing components of sustainable development, which can be represented by three distinct groups whose intersection represents sustainable development itself.

The concept of sustainability may be subject to different interpretations by different societies and policy makers, *e.g.* that the three dimensions (economic, social and environmental) should be given equal importance since the socio-economic aspects mainly concern the well-being of the present generation, while the environmental aspects concern care for the future.

But although these different interpretations are many, the one that is most respected is the one proposed by the Brundtland report,¹ and reported by Robert Solow,⁴ according to which sustainability is something more than an advertising motto or expression of emotion, and must constitute an injunction to preserve production capacity for an indefinite future.

This concept, must confront a socio-economic dimension of human aspirations for a better life: Happiness, Well-being, Welfare.⁵

Happiness (Happiness) is a subjective mental state, which depends only in part on objective conditions, with which it could even be in conflict, as a person could live in unfortunate situations but at the same time be happy.

Happiness is considered a fundamental goal of human behaviour since it personifies the subjective well-being of each individual.

As far as well-being is concerned, we identify a condition of objective well-being, a well-being that does not concern material goods or fundamental needs but simply contributes to making people happy, is what politics can put in place to improve the happiness of individuals, incorporating material needs such as freedom, education, security, justice.

Still in terms of well-being, unlike well-being, welfare is a more limited concept, easier to measure and dealing with material needs such as food, water and health, and can act as an intermediary knowing that it cannot cover every aspect.

This tends to replace the economic and social dimension of sustainability with a single aspect, well-being, which will have to be balanced with a further dimension: environmental sustainability.

When discussing about sustainability, we ask ourselves what resources are left in the hands of future generations, since it is inevitable that they will decrease over time; a decrease that, according to the economist Robert Solow, would be compensated by an increase in capital.

This statement gives rise to disagreement with other economists who argue that capital cannot replace natural resources and who argue that sustainability concerns the conservation of resources essential to survival.

These two views are referred to as weak sustainability and strong sustainability, respectively.

Weak sustainability is more risky than strong sustainability and places greater trust in the ability of future generations to cope with the environmental consequences of human actions. One example is the depletion of fossil fuels, a problem that is identified as weak sustainability, because if other energy sources were developed, the loss would be compensated for and there would be no problem of leaving future generations a diminished oil reserve.

Weak sustainability is therefore development in which wealth increases in such a quantity as to be able to deal with the consequences deriving from a fall in natural resources, and its strong point lies in calculating the cost of conserving an environmental good and its advantage.

It can therefore be expressed as follows:

$$\Delta (C+N) \geq 0$$

where (C=human-produced capital) must be greater than zero, while (N=natural capital) can assume negative values and the consequences of (N) can be accepted thanks to the rates of (C), aimed at introducing corrective factors capable of maintaining favourable living conditions for human beings.⁶

On the other hand, strong sustainability is in favour of measures to avoid environmental changes that could lead to irreversible loss and damage to the natural heritage of the ecosystem.

It is the most prudent form of sustainability, which knows how to include the maintenance of a natural capital (N), at least in a quantity not inferior to the inherited one, in a growth of the capital produced by man (C).⁶

Strong sustainability can therefore be expressed in the following way:

$$\Delta (C) \geq 0 \cap \Delta (N) \geq 0$$

One of the most widespread models is the one called “Three Ps”, Planet, People, Profit, according to which the Sustainable Corporation has profits compatible with the protection of the environment and respect for people: in this case the company pursues conditions of Corporate Sustainability.⁵

Analysing the model of the *Three Ps*: i) Planet, is the objective of preserving the functions of the environment as a supplier of resources, waste receiver and direct source of utility; ii) People, concerns the protection of health, safety of workers and consumers and in general the welfare of the people; iii) Profit is the company’s ability to achieve and maintain good economic stability, that is, the pursuit of profit that is based on the pursuit of the common good.

Another concept related to sustainability is that of Corporate Social Responsibility (CSR),⁷ which according to some positions is different from Corporate Sustainability, while another interpretation sees them as synonyms and the third as interdependent.

In the latter case, Corporate Sustainability is the condition for the survival and development of companies that is based on Corporate Social Responsibility.

In the 60s and 70s, Carroll⁸ developed the pyramid of social responsibility that CSR scholars still take as a reference.

This pyramid, has four levels of responsibility for enterprise: i) Economic responsibility: this is at the base of the pyramid and is the creation of value for the company and for the territory in which it operates; ii) Legal liability: the company must comply with the rules and regulations in force; iii) Ethical responsibilities: linked to the value and sense of fairness and justice, not subject to specific regulations, of the company, also considering the context in which it operates (for example for historical, political and cultural characteristics); iv) Philanthropic responsibility: the voluntary propensity of a company to carry out charitable work for the benefit of the community.

Organisations that take Corporate Sustainability as their model must incorporate these four principles of CSR into their business strategy and practices, because they enable them to put the *Three Ps* into practice.

The *Three Ps* are somewhat connected to the four levels of Carroll and precisely: i) Planet, finds its foundations in economic responsibility through the reinvestment of profits for the production of environmentally friendly goods and services; in legal responsibility, which requires compliance with specific standards on environmental legislation; in ethical responsibility, when the company makes a careful and rational use of natural resources; in philanthropic responsibility with programs that improve the environmental impact of the company’s activities; ii) People, is linked to economic responsibility because the production of goods and services that create wealth must be done with respect for workers, consumers and

investors. This is the case when staff and shareholders are adequately remunerated, when the safety and health protection of workers and consumers is taken into account to the highest degree. In the latter case, the legal responsibility that strengthens the protection and guarantee towards the stakeholders is respected. Ethical responsibility in turn presupposes behaviour that meets the expectations of a wider group of people. And finally, philanthropic responsibility with voluntary corporate programs for the benefit of the community (for example, interventions in schools and local communities); iii) Profit, it is in the very nature of the enterprise to be linked to economic responsibility when wealth is obtained with a high level of efficiency that guarantees satisfactory remuneration. The economic function must, however, be obtained in compliance with the regulations in force and therefore the profit dimension is automatically linked to legal responsibility.

An aspect that can be taken as an example of linking Profit to ethical responsibility is when sales prices are set in accordance with ethical principles so that they cannot be kept artificially high.

Finally, the Profit dimension is linked to philanthropic responsibility when the company supports important social causes that improve consumers’ perception of the brand and consequently increase sales.

As Lord Holme and Richard Watts put it: “Corporate Social Responsibility is the ongoing commitment of the business world to pursue ethical behaviour that contributes to economic development and that involves improving the quality of life of workers and their families, as well as of the local community and society in general.”⁷

Today, the Economic System cannot disregard the need to take into account sustainable strategies and for each company this entails different commitments depending on the activity carried out, the production processes and the resources used.

Sustainability is never acquired, it is not a goal that is reached once and for all, but it is a path and a permanent attention to continuous improvement that requires commitment and an honest and consistent attitude, open to dialogue and dialogue with stakeholders.

True sustainability is difficult without a profound spirit and attitude, without values that place man and the environment at the centre of life and productive activity and without a propensity for change, even when this involves the use of *sustainable* practices that are completely different from those used for years.

Why companies should care about sustainability

Until a few years ago, there was a widespread belief that attention to environmental impact was part of Corporate Social Responsibility, with purely legal or even ethical and moral implications, while disconnecting possible impacts on the business model and market expectations. Today, however, companies are aware that there is a growing link between green practices and success. In short, sustainability ceases to be merely environmental and extends its boundaries to the company’s *sustainable* business model.

Various aspects are leading to a growing interest in this issue and to a constant increase in investments. These include the sensitivity of the companies themselves, the need to adapt to regulatory developments (which have become increasingly frequent and stringent in recent years), the need to increase the quality of products and simultaneously reduce the costs necessary for their production, the improvement of their image and reputation in the eyes of consumers, who are increasingly sensitive to environmental developments and, finally, new market opportunities.

The companies’ sensitivity to environmental issues reflects the market’s increased attention to eco-sustainable consumption: it is

the combination of companies and consumers that creates the right synergy for environmental sustainability. The most far-sighted companies make responsible choices, increasing investments in energy efficiency, reducing waste, quality of biological resources, research into ecological materials for packaging. Those who make these choices are rewarded by results, and so virtuous examples are multiplying.

This is testified by the report GreenItaly 2016,⁹ produced by Symbola, Foundation for Italian Quality and UnionCamere, representative body of the Chambers of Commerce. More than 385,000 companies invested in green technologies and products in the period 2010-2015, or planned investments by the end of 2016, representing 27% of the total. In addition, the number of companies planning future investments in eco-innovation has increased over the last year: 134,810 (9% of the total) compared to 120,430 in 2015.

On the other hand, there is greater sensitivity on the part of those who buy, who are also prepared to boycott irresponsible brands. Citizens have become more aware of companies that take their environmental responsibilities seriously and seek to demonstrate a reduction in their ecological impact. One in two consumers in Europe is also willing to pay more for a sustainable brand.

This is the result of a study carried out by the Nielsen Global Survey in 2015¹⁰ at international level. On average, the age group most likely to pay more for sustainability is 21-34 years, followed by late teenagers (15-20 years). As for Italy, the main drivers that drive sustainable choices are trust in the brand (53%), if the manufacturer is eco-friendly (41%), packaging with low environmental impact (38%), commitment to social issues (33%), the positive impact of the company on the territory (31%).

Orientation towards eco-sustainability is therefore first and foremost a true mental approach to the company's organisation; a strategy to be pursued on a daily basis, which bears fruit in the medium term.

The fact that important companies value the environment certainly generates a process of emulation in the smaller ones, but it is clear that if the entrepreneurial fabric takes specific directions there is a practical and economic motivation and not only ideological.

A strategy based on sustainability not only serves to adapt to the impacts of future standards, but also to take advantage of important market opportunities provided by the continuous facilitation for the end consumer, thus turning into a competitive advantage and into a driver for value creation.

In past years, interesting regulations on energy saving have given a strong boost to the photovoltaic sector. Those who decided to take advantage of these incentives were able to build modern systems at a reasonable cost. This has led to energy efficiency in companies and in some cases to profits because the excess energy produced by the panels has been resold.

Other examples of cost-effective sustainability are all packaging reduction policies.

Often the packaging is too large for the product it contains or there are packages in the packaging. Choosing a packaging sufficient to guarantee the protection of the products and with an attractive design allows you to save money and be attractive without sacrificing aesthetic pleasantness.

A final aspect that makes sustainability a strong tool for corporate competitiveness is its integration into the marketing strategy.

In fact, it seems that in recent years consumers have become increasingly aware of the issue and consider attention to the environment as a synonym for quality.

This translates into a greater willingness to spend more on a product considered green.

Analysing environmental aspects, there are two main guidelines on which to build a sustainable approach: the improvement of

product performance (not only in terms of energy efficiency but also in terms of recycling) and the improvement of environmental impacts (energy, water, emissions, waste, resource management and so on) of production processes.

If the sustainability path is to consider not only impacts in absolute terms but also, and above all, improvements in relative terms, then no area should feel a priori excluded from this review process.

There are certainly activities that are intrinsically greener than others. But typically *polluting* activities such as steel, chemical, pharmaceutical and nuclear industries can also make an important positive contribution.

In some respects, the contribution can be more significant, which can lead to a typically grey activity that profoundly revises its production and business model with respect to a sector that is already intrinsically more sustainable.

The green approach does not remain the prerogative of specific economic and business areas, but embraces the entire system and all industrial sectors.

Stakeholders play a key role in communicating sustainability. As in commercial communication, the active involvement of the target represents today a key to the implementation of a winning strategy, also in the communication of sustainability; stakeholder engagement is a pivotal point to fully understand what can be the expectations and fundamental arguments. This openness must no longer be merely informative or aimed at reactively managing conflicts, but must lead to real involvement. An involvement that becomes real inclusion of the various stakeholders in the decision-making processes and that today is made possible thanks to the availability of a multi-directional communication; an involvement that must be effective and not superficial, that really affects decisions. All this starts from a correct mapping of the stakeholders to then arrive at a precise tracing, structured on more or less formal and formalized procedures and moments of engagement, of the effectively relevant themes (matrix of materiality). All this, finally, must be concretized with actions that reflect, in a more or less pervasive way, the indications of the stakeholders and for this reason correct communication, especially for those activities that are less visible but equally important, must become a tool with which to strengthen this positive relationship. In this way, the balance between the company and all its stakeholders becomes one of the highest expressions of sustainable development.

Different uses of ozone in medical and other fields

Ozone is a kind of *enhanced oxygen*. It's a fundamental gas for human life, because the one contained in the stratosphere is indispensable to protect the human species against ultraviolet rays in the sun. In the human body it is also produced by white blood cells with the aim of attacking and erasing foreign bodies. It is not by chance that, for more than 40 years, ozone has been used for its properties to cure various pathologies.

Italian legislation also recognized its validity in 1996, with Protocol No. 24482 of the Ministry of Health, which considers ozone "a natural aid for the sterilization of the environment", thus starting its use in health care, livestock, food, military and civil. An unstable gas and therefore impossible to store and transport. It must therefore be produced on demand, at the time of use, thanks to devices called ozonators, in which atmospheric or technical oxygen is activated by a corona effect generator, consisting of concentric electrodes.

Ozone therapy is diffused for applications – at low dosage – of

such gas in the medical field. The properties of ozone are different: anti-inflammatory, anti-edemigenous, anti-pain, dehydrating on the nucleus pulp, regenerating, healing, direct neurotrophic, antibacterial, antifungal and reactivating microcirculation. Over time, these have allowed doctors and researchers to test their application in the treatment of various pathologies. One of the most frequent cases of use of ozone is that of disc hernias. But the fields of application are numerous. These range from allergies to ulcers, from gastritis to bronchitis, from herpes to lumbosciatalgia, from acne to vaginitis, from cellulite to headaches, from carpal tunnel syndromes to otitis and rhinitis. In addition, dentists are increasingly using this medical technique to treat abscesses, support the healing of surgical wounds, combat bone necrosis in the jaw, and so on. Furthermore, this practice is essentially free of contraindications, if not for very rare cases, obviously if it is practised and advised by a doctor.

The very low cost of this gas and its prerogatives have, however, made it frequent to use also in agriculture. The main use is water purification, with the elimination of bacteria and microorganisms, but there are also companies that use ozone as a substitute for chemicals to disinfect food, machinery and containers used in daily work. In the same way ozone is used in fish farms to purify water, avoid the proliferation of parasites, reduce unpleasant odours, wash fish in fish companies and so on.

In the industrial sector, ozone is also used to sterilise containers, disinfect rooms, eliminate odours and clean up water. But also for more complex operations such as abrasion of plastics, accelerated aging of rubber or bleaching of fabrics.

Finally, domestic use is frequent to eliminate odours from the air or carpets, disinfect environments by reducing harmful agents, wash fruit and vegetables with ozonized water and so on.

Concrete cases of the use of ozone in non-medical settings

Dr. Massimo Buzzega, producer of the Azienda Agricola Buzzega Massimo e Italo SS Agricola, Italy, tells of his dual experience with the administration of ozone in fruit and vegetables. On the one hand, its use in cold stores, through a system of gas injection into the air, which has allowed an increase in the shelf life of the fruit and also the control of odors and the development of ethylene, naturally generated by products in a state of maturation.

On the other hand, thanks to the ozonized Biozon F1 oil – patented by Multiossigen srl and approved by SIOOT – Buzzega was able to quell the infestation due to a pear parasite, which was endangering the cultivation of an ancient quality of the fruit, known for its preserves and its use in gastronomy. It reports a diluted use of the product and distributed through an atomizer, and to have thus eradicated the weed at once.

Positive is also the experience of Dr. Gianfranco Ciarletti, oil sommelier, agronomist and olive producer in Trevi, Umbria, Italy, who boasts a family tradition of excellence and many awards – The 5 Drops of Bibenda 2016 – for their fine Night of St. Francis, rich in polyphenols and with high organoleptic properties. A record that risked being compromised by an invasion of oil flies, up to the choice to rely on ozone and thus sprinkle sick trees with the same Biozon F1 through the atomizer. A decision that so far has proved successful, with the extermination of the flies since the first cycle in July 2016.

Really innovative and revolutionary is the choice of Dr. Paolo Garbelli,¹¹ veterinary and surgeon, specialized in homeopathy, co-owner of the Garbelli brothers farm in Bagnolo Mella, in the province of Brescia, which has many years of experience in the

application of ozone in animal husbandry. Very sensitive to consumer health and to the production of healthy and tasty pork, Garbelli has always preferred phytotherapy and homeopathy to the traditional approach. And it is by virtue of this ethical vision that it has preferred oxygen-ozone to antibiotics, thus reducing by 60-70% the medications, including probiotics and prebiotics, in addition to antibacterials.

His company is equipped with more O₃ generating plants. The largest, which mixes ozone with water for the constitution of swill – feed – and for the watering system of the pigs, a second to purify the air and introduce the oxygen-ozone in the stables through a system of conductor on the ceiling and finally a third close to the silos reserved for the storage of serum.

Such a turning point that in a year and a half the farm has been able to reduce the costs for the treatment of infectious diseases, the cleaning of shelters, the containment of odours, the purchase of acids and mortality of animals. Undisputed advantages, including healthier meat and an increase in exports to the United States, more attentive than Italy with regard to the purity of the product and the concentration of antibiotics.

Discussion and Conclusions

From the definitions of sustainability, it is evident that the concept is wide and multidisciplinary and that the enterprises should care about it for several reasons, mainly related with management, corporate reputation and finance. The two main dimensions of sustainability investigated in the present paper are the environmental and economic ones. The former relates to low environmental impact that any technique, strategy or technology employed by an enterprise could have. The latter relates on the economic and financial feasibility of an enterprise strategy in the medium and long terms.

Ozone is an inorganic, natural molecule; it is spontaneously produced in the stratosphere by ultraviolet radiation, in the atmosphere by lightning generated electrical discharges; artificial ozone production is conducted by subjecting dry atmospheres containing gaseous, molecular, electric discharge or effluent oxygen.

It is an oxidizing agent, whose oxidation potential (redox) is only lower than that of fluorine. Compared to oxygen, it shows high reactivity in the reaction phase and low activation energies for heterogeneous reactions. It has a strong oxidising power directly on the surface of noble and non-precious metals, such as silver, lead and copper, and of metalloids such as sulphur.

It acts quickly with regard to organic substances, giving rise to numerous chemical reactions. Particular is the reactivity with respect to the double bond C=C of unsaturated organic substances, a reaction that is commonly defined as ozonolysis.

For some decades now, industrial and agricultural applications of ozone have been based on the great disinfectant and clarifying capacities that this gas proves to have. Ozone, thanks to its great oxidizing power, is able to break down the large macromolecular components that are the basis of the vital integrity of bacterial cells, fungi, protozoa and viruses. This powerful disinfectant action, with a wide spectrum of action, is used both in water disinfection for purification and in waste water treatment.

Many studies have also shown that ozone is more effective than chlorine in eliminating certain viruses that find great vitality in drinking water (such as EBOLA virus). For this reason, it is not surprising that ozone is also widely used in swimming pool sanitation (Australian Olympics 2000)¹² where it induces a saving of 80% chlorine, a reduction in water make-up and does not require any intervention of personnel as the system is automated.

The ozonization of swimming pools also makes the water more crystalline (as it reduces the concentration of trihalomethanes) and more filterable (breaking the large organic molecules). In many European countries, but also in Canada, waste water is clarified by the use of ozone. Currently, this process is divided into two phases: a first phase of primary ozonization, followed by phenomena of flocculation and filtration that aim to eliminate heavy metals or organic substances that cannot be completely destroyed by the oxidizing power of ozone and a second phase of secondary ozonization, lasted longer that destroys any pathogenic microorganism and is then followed by filtration on activated carbon that blocks micropollutants resulting in the final drinking water.

Also interesting is the possibility of dissociating oxidically and then destroy with ozone and simultaneous ultraviolet irradiation the biphenyl perchlorate (which is a derivative of DDT), a substance very difficult to eliminate.

Other industrial applications of ozone are in the fields of smoke abatement, hydroculture, agro-industry, ceramics, microbiology, sugar and paper refining as bleaching agents, disinfection of glass vessels and so forth.

Especially in agriculture and animal husbandry, ozone is proving to be a powerful alternative to more traditional disinfection methods, first antibiotics. Several bacteria and viruses can be rendered inactive through the use of ozone.

For these reasons, ozone can be regarded as a driver of environmental sustainability for the enterprises using it as an alternative to other – non-natural – means of disinfection. By not leaving any chemical residue, ozone is absolutely ecological. As proof of this, it has been defined as a safe agent *GRAS* by the US Food and Drug Administration.¹³ Besides of this, specific scientific societies (as, for example, the Italian SIOOT) define guidelines on how to use ozone in several fields, in order to respect environment and people.

From an economic and financial point of view, ozone has low production costs, when compared to other chemical alternatives.

The cost/benefit ratio of ozone is much higher than that of other disinfection systems. For example, in the disinfection of waters, the investment costs of ozonization are higher compared to chlorine dosing plants. In reality, this comparison is not very expressive, because the two disinfectants have different purification chemisms and maintenance costs, over time, in favour of ozone.

Also in the medical field the use of ozone is cost sensitive when compared to the assumption of antibiotics or to surgical treatments for diseases like disc hernia, fibromyalgia, neurodegenerative syndromes, rheumatoid arthritis and others.

Summing up, from this preliminary qualitative analysis the use of ozone in different fields appears to be a driver for ecological and economic sustainable development for the enterprises. Further studies will assess the same issue by considering, more in deep, the use cases from a quantitative point of view.

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