ENVIRONMENTAL PROBLEMS OF THE CERAMIC TILE FIRMS. TORRECID CASE STUDY.

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1. INTRODUCTION

The word cluster was coined by Michael Porter during his work in "The Competitive Advantage of Nations", which concluded that the grouping of firms and the specialisation of each firm in their respective productive activities had a positive impact on competitive advantage. (Practical Team, nd)

Nowadays there are many clusters all over the world, some of the most famous ones are Sillicon Valley, Hollywood or Wall Street. In our country, there are also these groups of companies, the best known of which are located in the Basque Country, Asturias, Catalonia and Castellón.

The ceramics cluster in Castellón is the most important in our autonomous community as it accounts for a large part of the gross domestic product of the region. This large industry has a series of externalities that have an impact on the environment, one of the most important of which is the pollution it generates and the large amount of energy it consumes during the manufacturing processes.

In recent years, industry and the environment have generated controversy. For this reason, companies are striving not only to comply with environmental regulations, but also to innovate and create processes, products and services that respect nature and provide added value to users. This is how Ecodesign was born, a trend that more and more companies are adopting. Ecodesign consists of obtaining goods and services that are in line with the environment, that is, producing in a respectful and responsible way.

For this reason, ceramics companies are not lagging behind, and are fighting to create a brand image that is committed to this situation. More and more are joining the practice of the "three Rs": recycle, reuse and reduce. To make this possible, they are undertaking major plans aimed at a final product that meets customer expectations and is of the highest quality with the least possible resources. The Government of the Generalitat Valenciana drew up a document aimed at this industry in order to provide guidelines and improvements to follow in the production processes. This document, "Good Practices in Ceramics", focuses on improving ceramic production in order to achieve maximum quality with the lowest possible waste and emissions. Among the companies in the ceramics sector we find world-renowned brands with great prestige. Some of them are Porcelanosa, Torrecid, Marazzi, Inalco, Pamesa or The Size.

In this paper we will focus on one of these companies: Torrecid, a research work has been carried out on this company, in which we have been fortunate to be able to conduct several interviews with two professionals who work here.

Torrecid is a multinational colourificio dedicated to the supply of products, services, solutions and trends to the companies that make up the ceramic and glass industry. It is a benchmark for innovation for the rest of the entities that form part of the cluster. It has developed numerous techniques that are aligned with the interests of its consumers and respect the environment.

Therefore, we will focus in more depth on a description of the ecofriendly lines of business of the company Torrecid, focusing on their repercussion on the rest of the companies and on society and on the advantages and disadvantages that they entail for the company and for the environment. We will also analyse the processes from the point of view of "Good Practices in Ceramics", seeing if the company follows the guidelines recommended by the Generalitat Valenciana and if not, how it could adapt to follow them and even implement them to make a more positive change and have a perspective in tune with the natural environment.

Finally, we will analyse from the point of view of the company and according to the current situation and laws, the main challenges faced by the company in the ceramics sector.

2. CLUSTER

2.1 What is a cluster?

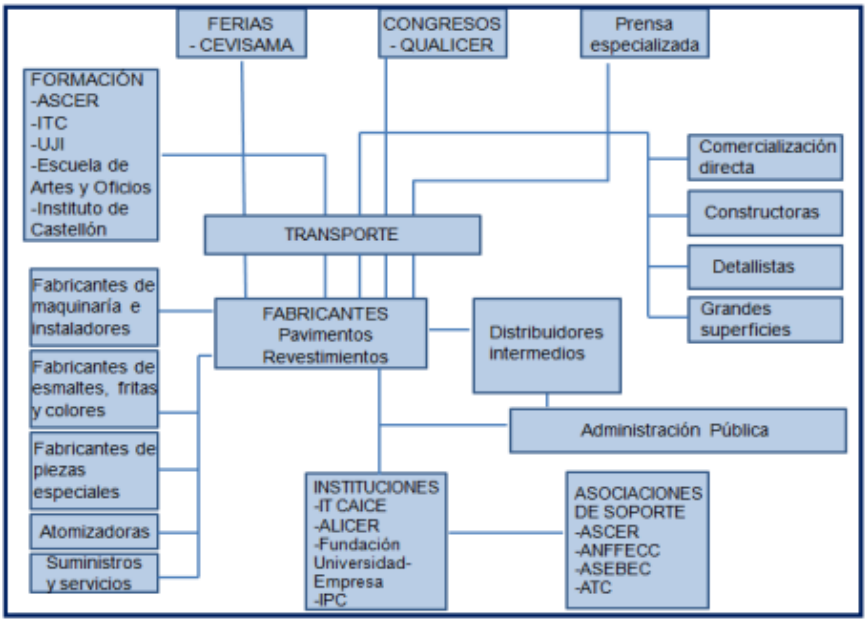
According to Porter (1999) clusters are:

" Geographical concentrations of interconnected firms and institutions, belonging to a particular field, united by common features and complementary to each other. These firms share local resources, make use of similar technologies and often form cooperative linkages and alliances. (Porter, 2000).

Therefore, we understand a business cluster as a cluster formed by the geographical concentration of specialised suppliers, service providers, interrelated companies, industry partners and connected entities linked to each other. Thus generating a production system capable of directing and shaping itself, giving rise to synergies and competitive advantages. (APD Editorial Office, 2019)

If we talk about intervention, it should be noted that in a clustering project and in its productive integration and development of the business network, not only private agents come into play, but it also requires the presence of agents from the public sector, such as educational institutions, business chambers or foundations and non-governmental organisations. (Terrada, nd)

Figure 1: Actors involved in the ceramics sector



Source: Terrada, study of the ceramic sector in the Valencian Community.

In many sectors, clustering is recommended at the upgrading level for companies, as it allows them to capitalise on the economic relationships between specific industrial sectors and also helps to define economic development strategies in the region where they are located. It is important to highlight that clusters in general do not have a defined strategy, but rather the different companies that make up the cluster have their own strategies, and these strategies must be carefully chosen and implemented in order to position themselves comparatively (Terrada, nd). (Terrada, nd)

2.1.1 Advantages of a cluster

According to Elías Rodríguez, the main advantages that a cluster can generate are the reduction of costs, the use of economies of scale, the use of resources, the increase in productivity, the growth in innovation capacity and the possibility of improving the competitive position. (Rodriguez, 2020)

A cluster functions in a similar way to an ecosystem; if both are well structured and function correctly, they are all advantages. The result of a clustered economy benefits companies, whether they are large, medium, small or micro enterprises, as it generates connections between them and allows them to face the future with greater guarantees. (Aguilera, 2015)

It has been shown that companies perform better when they collaborate on innovation projects, as they pool expertise, resources and the strengths of other companies. (Novo, 2015)

In addition, they favour the specialisation of companies in products, processes and machinery in the sector, thus increasing the competitiveness of companies and strengthening production chains. (Terrada, nd)

One of the most important advantages for society is the job creation and the prestige it creates in the area where the companies specialising in the sector are located. It is currently estimated that there are around 3,000 specialised clusters in Europe and it is estimated that they represent around 54 million jobs.
employment in the european union. (Business Planet, 2021)

2.2 Types of business clusters

Firstly, we can divide clusters into vertical or horizontal clusters: vertical clusters are those that are vertically integrated, i.e. that group together companies that are linked through supply chains.

Horizontal clusters, where industries share knowledge and technologies, operate in similar markets and their services or final products are similar. They feed back into each other in terms of technology and innovation (Up Spain, nd). Within this type there are more variants of clusters:

- The industrial cluster, formed by a group of companies related to the production of goods and services and their distribution. examples are the automotive industry, mining, tourism or oil.

- The high-tech or technology cluster, in which all companies have in common their high technology, which is adapted to the knowledge economy, are usually located in important universities and research centres.

- Factor endowment clusters, born with the existence of comparative advantages and grouped together, are usually associated with particular geographical elements, such as the orange cluster in Castellón or the wine cluster in California.

- Value chain clusters are usually the most common in business. It consists of the grouping of businesses that are dedicated to the purchase and sale of products and/or services between them.

2.2.1 Examples of clusters

As we have already seen, there are many variants of clusters, we are going to talk about three real clusters that exist today, two of them are known worldwide (Sillicon Valley and Hollywood) and the other is a European cluster, known as Imago-mol, which is gaining more and more importance thanks to its research input and processes.

North East Regional Innovation Cluster for Structural and Molecular Imaging (Imago-mol).

Imago-mol is a specialised Romanian medical imaging cluster that has gained vital importance during the last year. Its objectives are to support the growth of economic competitiveness in the field of medical imaging by developing a cooperation-based framework aimed at diversification and optimisation of services. (Imago-mol, 2021)

It offers its services and contributes to facilitating and training business projects, as well as fundraising and promotion to help create them, linking R&D institutions and hospitals with companies. To do so, it uses marketing channels (social networks, websites, newsletters, etc.) (Business Planet, 2021).

In the context of the pandemic, they have created a web application that allows users (citizens and hospitals) to find the stock of medicines they need in the nearest pharmacies and to cope with shortages of PPE. They have also created a series of platforms for businesses to help and support them in coping with the enormous challenges posed by the coronavirus (Mihai, 2021).

Technology cluster, Silicon Valley.

If we talk about cutting-edge technology, Silicon Valley comes to mind. It is located in the San Francisco Bay Area, in Palo Alto, California, and is home to world-famous companies and universities such as Google, Apple, Facebook and Stanford. (iProfessional, nd)

In the mid-1990s, some of the companies mentioned in the previous paragraph emerged in the area, which created a large number of new start-ups of more technology companies and attracted venture capital firms located in other areas. This created a relationship between entrepreneurs and companies involved in financing.(Somoza, 2020)

The business cluster effect also created a cluster effect on the labour market, as more and more prestigious companies from outside the Sillicon Valley area went there in search of qualified personnel.

These companies have a large amount of financial resources, which makes it possible for them to reach such high technological levels, in addition to the level of knowledge, the values and attitude of the people who make up the company and the optimism with which they approach each project. One of its success factors is the wide range of universities it enjoys, thanks to Stanford University (iProfessional, nd).

Hollywood film cluster.

This world-renowned cluster, located in Los Angeles, California, is the largest and most powerful film industry in the world. It began in 1920 as an investment by Jews who wanted to create a small business that was aimed at an immigrant audience. It was made up of studios such as Metro Goldwyn Mayer, Warner Bros, The Century Fox, Paramount and many others. (Barron, 2017)

Within the Hollywood cluster professions we find all types of professions and professionals that are needed for a film to appear on the big screen: we have the screenwriters, the composers, the directors, the producers and the actors. Celebrities such as Brad Pitt, Quentin Tarantino, Julia Roberts and Angelina Jolie are all part of this. (Monografias, nd)

It creates a large number of jobs, around 310 000 people work there, creating a large amount of millions of dollars annually. The film industry contributes 5% to the country's GDP. (Barron, 2017)

3. INDUSTRIALISATION AND THE ENVIRONMENT

From the beginning of industrial expansion to the present day, a number of externalities, both positive and negative, have affected and continue to affect the environment we live in.

One of the main problems is industrial pollution generated by manufacturing processes that affect air, soil and water quality, generate waste and consume large amounts of energy. Industrial pollution is understood as any emission of noxious substances that are toxic or hazardous, which directly or indirectly come from industrial installations or processes and which flow into the natural environment (Querelle and Cia, 2015). In addition, industry brings with it the massive exploitation of natural resources, resources that are finite and in the case of some, such as oil and gas, are not renewable. Among the most polluting industries are the metallurgical and chemical industries.

It was during the 1990s, when the environment was incorporated as a code of behaviour in the business world due to the cultural prominence that planning and marketing began to have in the development of companies, when it began to be seen that there could be a short-sightedness on this issue and that this could generate negative consequences in the environment that could be irreparable in the future. (Cavala, 2014)

The existence of external actors such as the government and its environmental restrictions, associations and foundations or even the local population that exert pressure and influence companies to respect the environment. Furthermore, complying with government regulations on emissions, using environmentally friendly products, reducing consumption and emissions, recycling and reusing not only benefits companies internally in terms of innovation, growth and commitment, but also has a positive impact on end consumers by positioning themselves in the market as committed companies, which adds value to their products.

Industry is currently responsible for more than half of the total emissions of atmospheric pollutants and greenhouse gases, among others (Retema, 2015). We can speak of demanding and rigorous limits accompanied by greater severity in terms of control and penalties for non-compliance with regard to emissions, noise pollution or

discharges produced by industry. It is to be hoped that the policy instruments currently in place at both national and international level will reduce these emissions.

To this end, measures have emerged that seek to regulate these limits in a more indirect way, such as:

- The emergence of new market and financial instruments (voluntary agreements, cohesion funds, fiscal or economic grounds), horizontal support instruments such as education or research and development.

- Ease of access to existing environmental information.

- The impact of using increasingly accessible technological improvements.

- Public participation in the development of environmental standards and policies.

- Development of documents known as "best available techniques" to be used as a guide in major industries.

Creating a stable and robust industry is one of the main challenges that the European Union wants to achieve by reducing the carbon footprint and making use of circular material flows (Gouardères, 2021). This is one of the industrial policy strategies, which aims to create a fully renewed industrial sector that does not resort to natural resources as a first option.

The problem arises in the implementation of the above, as emission-related directives are often independent or unrelated to these causes. The progress of industrial sectors towards zero pollution now requires much stronger and more entrenched legislation and its consequent implementation and monitoring to ensure a clean and sustainable industry of the future. (Retema, 2015)

Being aware of the repercussions that industry can and does have on our environment is something that must be taken into account both now and in the future, as it is one of the main causes of environmental deterioration and must therefore be aware of this and seek, propose and implement solutions that benefit both parties.

3.1 ECODESIGN

Eco-design is a practice based on the incorporation of environmental principles in the development phases of products and services. Companies focus on preventive measures and what these mean, as mentioned above, added value to the final product, quality and differentiation from the rest. (Abaleo, 2017)

The aim is to achieve environmental improvement throughout the process by reducing the negative externalities that industries have on our environment, not only focusing on the final product, but also on the recycling, reuse and conversion of the waste generated. "Ecodesign is to identify, at the very moment a product/service is planned, all the environmental impacts that may be produced in each of the phases of its life cycle, in order to try to reduce them to a minimum, without detriment to its quality and applications". (AENOR, 2020)

It is impossible to talk about eco-design without talking about circular economy, as it is a fundamental component. It gives rise to a closed circuit without waste, prolonging, as we have already seen, the value of the products and services generated under this philosophy.

3.1.1 ISO 14006 Ecodesign Management Certification

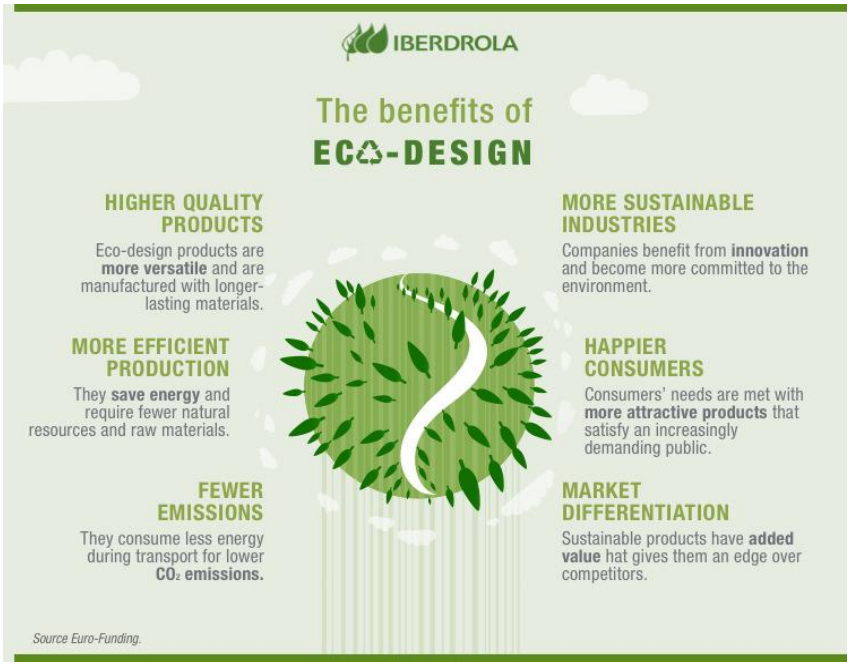
The Ecodesign certificate issued by AENOR guarantees the adoption of a management system designed to identify, control and improve everything related to the environmental aspects of the products or services offered by the company, providing the necessary information for users about the products that have improved with the design in accordance with the UNE-EN ISO 14006 standard (AENOR 2020).

This, of course, has a positive impact on the organisation, as it is a guarantee that it complies with environmental legislation and includes current environmental requirements in its day-to-day operations and designs and develops its activity with the challenge of environmental improvement in mind. Finally, it also ensures a reduction in overall costs, such as lower consumption of raw materials, reduced packaging and packaging (Iberdrola, 2021).

One of the pioneering companies in practising and introducing eco-design in Spain is Iberdrola. It is a company that supplies and markets energy. "We have to produce better and more efficiently for an obvious reason: raw materials and natural resources are not infinite and could run out if we do not take care of them" Iberdrola 2021.

From its point of influence in the industry, as it is one of the main energy suppliers, it aims to raise awareness among its customers of the importance of energy savings. In the following image we can see the six main benefits of applying the practice of eco-design in industry and the advantages they bring to companies (Lumiber, 2019).

Image 3: The benefits of Eco Design



Source: Iberdrola

And not only from the point of view of companies, but also from the point of view of consumers and users, who are increasingly opting for eco-products as they are more durable, natural, prevent environmental impacts and have a higher quality, which is a determining factor for consumers when choosing a product. (Iberdrola, 2021)

4. CERAMICS CLUSTER IN SPAIN.

The Spanish ceramic tile industry is one of the industries with the greatest potential and dynamism in our country. Within the ceramics sector, at a global level, it is considered a leader in technological development, design and quality. (Ascer, 2019).

As we have already seen, a cluster is made up of a group of companies in the same sector located in a specific area, so the Spanish ceramics cluster is located in the province of Castellón de la plana. In this province, 80% of the companies in the ceramics sector are located and give rise to 95% of national production, specifically in the area between Alcora, Borriol, Onda, Nules and Castellón. (Ascer 2019)

Image 2: International Ceramic District in Castellon

Source: Inter-University Institute for Local Development
Department of Economics. Universitat Jaume I

This cluster includes all the companies necessary for the sector to function from the beginning of the process to the final product: raw material suppliers, extractive companies, colouring companies, spray-drying companies, flooring and coating companies, frit, glaze and ceramic colour suppliers, companies specialising in design and customisation, companies that manufacture special pieces, etc. (Castellón Plaza, 2019)

It also includes public domain organisations specialised in R&D such as the Institute of Ceramic Technology (ITC) and the Jaume I University, the latter offering a degree in chemical engineering, a university master's degree in Science, Technology and Applications of Ceramic Materials and University Expert courses in Ceramic Materials Processing, (Fundación Universitat Jaume I-Empresa, UJI, 2016). It has institutions of private domain where we include the trade associations: Spanish Association of Ceramic Tile Manufacturers (hereinafter Ascer), National Association of Manufacturers of Frits, Glazes and Ceramic Colours (hereinafter Anffecc) and Spanish Association of Manufacturers of Machinery and Equipment for the Ceramic Industry (hereinafter Asebec). (Ascer, 2019)

This is a great support to the cluster and acts as a driving force for innovation, it is a systemic behaviour. One of the biggest and most important innovations was the development of inkjet printing in the last decade by the companies Kerajet, Ferro and Esmalglass with the help of the printing cluster located in Cambridge, UK. (Hervas-Oiver, Lleó and Cervelló, 2015)

If we go into detail, in the auxiliary industries, frits and glazes are of great importance in the process (Molina, 2002). The enamel industry in our province leads the ranking with some 26 firms, including Colorobbia, Esmalglass, Ferro, Torrecid, Esmaltes, Fritta, Kerafrit and Vidres, which together export 66% of total production (Anffecc, 2010).

Approximately 80 % of the production of this industry is exported to other countries and the rest is sold on the domestic market. In the following tables we can see the significant amount of employment generated by this industry, the production in millions of square metres and the sales in millions of euros of this sector in the last year. As can be seen, it creates a large number of jobs, so we can deduce the importance of the human factor in this sector. (Ascer, 2020)

Table 1: The Ceramic Sector in 2020

El sector cerámico en 2020	
Producción 488	Exportación 2.941
Empleo 16.100	Ventas totales 3.842

Source: ASCER

In the course of the last five years, it is from 2019 onwards where a decrease in production is seen, which, although exports increased, may be due to the decrease in sales in the country, which has an impact on the total market figure, causing it to decrease.

This fall in national demand can be attributed to the rise in energy supplies. The tile sector consumes large quantities of natural gas and variations in its price have a great impact on the increase in costs, according to the statements made by the Vice President of Ascer, Francisco Ramos. During this period, the prices of natural gas and electricity in our country were among the highest in the European Union, which meant a great disadvantage with respect to its competition, as for example happens with the ceramic cluster of Sassuolo, located in the north of Italy. We can designate this cluster as its main European competitor. (Pitarch, 2018)

Table 2: Production and sales of the ceramics sector in the year 2020

Producción y ventas del sector					
	2016	2017	2018	2019	2020
Producción	492	530	530	510	488
Ventas mercado nacional	746	824	870	939	901
Exportación	2570	2686	2727	2818	2941
Ventas totales	3316	3510	3597	3757	2827

Ventas en millones de EUR y producción en millones de metros cuadrados

Source: ASCER

5. HOW DOES CERAMICS WORK?

This is a very dynamic sector and one of the most active in our country; Spanish ceramics is a great reference for the rest of the countries in terms of quality and innovation.

We are now going to describe the process that a tile factory goes through from the beginning until the tile is obtained. We were lucky enough to visit the production and development plants of the Azteca Cerámica tile company, where the head of the development department gave us a tour of the facilities, explaining how the process worked and answering any questions that arose about the development of the products, from start to finish.

5.1 Manufacturing process of ceramic parts.

It is important to highlight the step prior to the arrival of the raw materials at the factories. After the clay is extracted, it is mixed and treated with other materials such as feldspars, sands, carbonates and kaolin to obtain mechanical strength.

Once the previous procedure has been completed, these are the phases that give rise to the ceramic piece:

1. The reception of the atomised material (which has been previously treated for its use). This raw material arrives in lorries at the tile factories, is unloaded and stored in different silos, depending on the type of soil in question. We find varieties such as porcelain, stoneware and porous (white or red).

2. Pressing to shape the ceramic piece. From the silos where it is stored, the earth arrives via conveyor belts where the paste is moulded to achieve the size and shape, giving rise to what is called support or bisque.

3. Drying the piece to reduce its humidity level. Then, after pressing, the pieces arrive at the dryer through a walkway, whose function is to eliminate the humidity they may contain, thus increasing their mechanical resistance.

4. Glazing the piece. A coating or varnish is added to the bisque or support, which acts as a protector, waterproofs it and eliminates porosity. The glazes applied can be transparent, matt, glossy, opaque or coloured.

5. Decoration of the product (in the case of a decorated product). Once the pieces have been enamelled, we move on to the decorative phase, where we find different decoration tactics: stamping rollers, digital printing techniques or screen printing using screens and stamps.

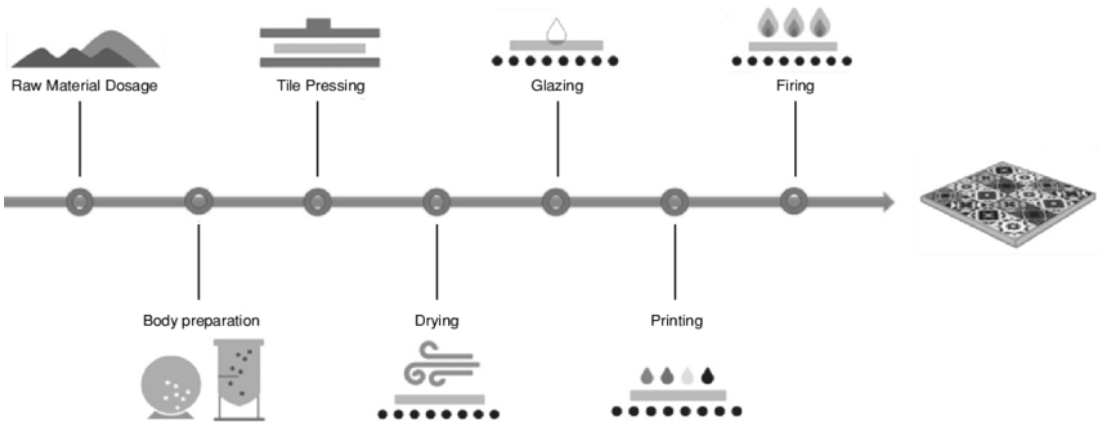
6. Before firing, there is another drying phase. Here the moisture that has been generated during glazing and possible decoration is removed.

7. Firing the piece in the kiln. The pieces transported by ceramic rollers are introduced into a kiln, where heat is applied by means of natural gas and air burners, giving rise to the tile.

8. Classification and packaging. The product undergoes a series of checks and inspections in order to locate possible defects (scratches, poor decoration, punctures, cracks, etc.) in the pieces and eliminate them if necessary. Once the control process has been completed, they are boxed and packed on pallets.

9. Storing the final product for distribution to the customer. Pallets of tiles are moved to a logistics warehouse awaiting loading and distribution.

Image 4: The ceramic tile manufacturing process



Source: Research Gate

The above steps cause a large environmental impact due to the amount of substances used, the first seven steps are the ones that require the most attention in order to prevent damage to the environment.

The extraction of raw materials, atomisation, transport and storage of the raw materials generate a large amount of dust, generate high levels of noise pollution and modify ground conditions.

The volume of emissions released into the atmosphere during the transport and handling of raw materials not only affects the ecosystem, but also has an impact on the health of the workers who handle them. In addition, these processes use gaseous compounds that can be equally harmful to health.

As for the glazing of the tiles and the gas used to run the kiln, they also contribute to the emission of toxic substances, chlorides, oxides and metals (Balgori 2004). A large amount of solid waste is generated, which can be particularly hazardous: lubricants, grease, packaging waste, etc. Ozone ranks as the main pollutant, it is the most widespread and its levels continue to increase.

This also affects water quality, the water around ceramic factories can be contaminated with solids, anions, metals, organic fibres and toxic residues.

According to the Air Quality Report of Ecologistas en Acción for the past year 2019, even though the levels of harmful particulate matter and nitrogen dioxide emissions had been reduced, around five million citizens were still breathing polluted air. This report points to the ceramic area in the province of Castellón as the main area of pollution, which extended to the surrounding rural areas. The previous year, pollution levels in the area were shown to have exceeded the limits set by law, damaging nearby crops and ecosystems. (Castellón Plaza, 2019).

Specialised environmentalists propose as a solution to reduce these problems the adoption of the best available industrial techniques, as well as encouraging energy saving and trying to reduce consumption levels. (Castellón Plaza, 2019)

5.2 BAT'S in ceramics

The European IPPC Directive: The European Integrated Pollution Prevention and Control Bureau (hereafter EIPPCB) and the Real Decreto Legislativo 1/2016[1] form the basis of environmental legislation that aims to reduce the maximum possible amount of hazardous emissions from the most polluting industries.

Thus, these laws are responsible for defining and controlling emission limits, times and values. In doing so, they take into account Best Available Techniques (hereafter BAT's), including monetary costs, installation, location and environmental characteristics. BAT's are developed on an industry-specific basis. (Ministerio de Medio Ambiente y Medio Rural y Marino, 2011)

In the case of the ceramics industry, a number of measures are in place to try to reduce the environmental impact and encourage the reduction of emissions, the recycling of materials, the saving of water and energy and the reduction of chemical or toxic materials.

According to the information set out in the document prepared by the Ministry of the Environment and Rural and Marine Affairs, they involve special attention:

- Emissions of dust particles that are generated both in production and storage. In most cases, enclosure solutions, powerful extraction systems and filters are used to solve this problem.

- Pollutant gases emitted during the process, reduction of which can be achieved by the addition of calcium-containing additives that reduce harmful materials or the use of filters.

- The high energy consumption, a practice is applied that helps to reduce, recovering the heat given off by the kilns where the ceramics are fired and also reduces greenhouse gas emissions.

[1] Real Decreto Legislativo 1/2016, del 16 de diciembre, approving the revised text of the Law on Integrated Pollution Prevention and Control.

- The noise level, as mentioned above, noise pollution is present at all stages of the process, and this can be avoided by enclosing or isolating the noisiest machines or by using soundproofing techniques.

As we have seen, the ceramic manufacturing process is quite hazardous from an environmental and labour point of view, but it can also have a positive effect by applying appropriate and adapted BAT's techniques.

When we talk about ceramics, we are not only referring to tiles, but also to the manufacture and decoration of tableware, sanitary ware and in construction. Especially in the latter, ceramics are taking an important role in recent years, its use in interiors has positive final effects, there are coverings basically made of special ceramics that, for example, maintain and radiate heat generated in the house, absorb the sunlight that is emitted during the day and transform it into heat (Cerem Comunicación 2016)

6. TILE COMPANIES COMMITTED TO THE ENVIRONMENT.

As we have already seen in the section on industry and the environment, production is one of the main causes of damage to the environment in which they are located. All companies should be aware of this and dedicate their efforts and resources to finding a solution to this problem, focusing on something that not only provides added value or differentiation, but also on something ethical that can improve the environmental situation.

In the ceramics cluster, beyond compliance with environmental regulations, there are companies that are concerned about improving their production processes and adapting them to this problem, and they allocate a large part of their income to transforming the negative externalities that are within their reach. These include entities such as (Ascer 2019):

- Torrecid with its environmentally friendly ranges and its production systems, which we will explain in the following section.
- Porcelanosa, which collaborates with companies such as Iberdrola in the search for electrification and green hydrogen projects.
- Esmalglass-Ítaca, with the creation of its "Natural inks" line.

6.1 Torrecid

Colorificio Torrecid, founded in 1963, is a multinational company dedicated to providing products, services and solutions to the ceramic and glass sector within the future trends. It provides products such as raw materials, frits, glazes, ceramic dyes, precious metals, ceramic decoration (third firing[2]), additives, digital printing (inkcid) and advanced ceramics. It is based in Alcora, Castellón and is currently present in 28 regions and its customers are located in around 130 different countries (Torrecid, 2021).

[2] The third firing in ceramics is a technique that consists of firing a previously fired ceramic piece that has been decorated and needs to be fired again, for which it is not necessary to apply such a high temperature as in the first firing of the piece.

What is the function of a colorificio? Well, according to Juan A. Reyes, the function of this industry is to provide the necessary elements to the manufacture of ceramics, which after different types of processes, such as the process of melting minerals in a kiln, give rise to the essential materials for the manufacture of tiles. Their products provide the pieces with essential qualities and relevant aesthetic characteristics. Broadly speaking, these materials are: frits, glazes, colours, and other adjuvants to the process (engobes, lustres and additives in general) (Reyes, nd).

Torrecid is a role model for innovation and, as we will see below, it is constantly striving to create new solutions and future trends that allow it to develop great competitive advantages and thus provide great added value. All of this is based on its five fundamental pillars: ethics, service, marketing, quality and innovation. (Torrecid 2021)

6.1.1 Torrecid's green product lines

As we have seen, innovation is a pillar of the company's day-to-day business, its growth is largely related to the creation of cutting-edge and innovative solutions and this has allowed it to create a great competitive advantage for its customers. It has developed the "EcoInk-Cid", "Smart Cid", "Slim Cid" and "Slim Cid floor" techniques, all of them business lines committed to the current environmental situation. All the information detailed below has been extracted from the Torrecid and inkcid websites and from the information extracted from the interviews made:

ECOINK-CID

This group has been investing in research and development in inkjet inks for more than fifteen years and has achieved magnificent results, opening up the world of ceramics to new possibilities. That is why it is a leader in ink innovation and development, being the largest producer and number one worldwide in sales of pigmented inks (Inkcid, 2021)

It is part of the "Inkcid" solution, which is a global solution created by Torrecid for this sector that can be used with all existing digital printing machines on the market. This technique offers unlimited aesthetic varieties, all based on the most complete range of existing inks. It offers consumers the best colour gamut with maximum reliability and consistency for the various printing systems available on the market. It saves time in

production processes with the use of clean technology, which makes full use of the ink used and gives rise to a variety of pieces created with the same design.

This allows for a number of process and management advantages that result in the final product:

- It is a decoration technology without the need to establish any contact with the tile, thus avoiding possible breakages in the pieces during the decorative process.
- It allows decoration on any surface, regardless of whether its surface is rough or smooth.
- The inks are supplied pre-packed and ready for use without any prior preparation.
- All ink is used, i.e. no waste is created during the process.
- It can be used in the various existing processes of ceramic manufacturing (cladding, glass, porcelain, double firing, third firing) and glass.
- With a minimum number of inks, all possible colour combinations can be achieved.
- The stages of preparation, control and storage of inks are eliminated from the production process, resulting in greater efficiency and time availability.
- Product stock is reduced, avoiding unnecessary storage.
- It allows the entire piece to be decorated, right up to the edge and even areas with a different relief are decorated with the same definition.
- It offers an infinite number of different decorated pieces.
- It allows the development of new ideas and designs in the pieces.
- Offering the possibility of a customised product tailored to the client's needs.
- The print quality is the most superior to other technologies on the market.

- It allows workers to use clean technology in a much cleaner and healthier working environment.

Now, what was the starting point to begin researching and developing this technique? Both in our country and in Italy, ceramics is a major industry, and in these countries the regulations with emissions and toxic products started to become more demanding as the ceramics industry advanced.

Ecoink.Cid is the first water-based glazing and decoration solution on the ceramics market. It offers the possibility of creating glazes with different gloss levels, matte glazes with all possible finishes, inks in all chromatic colours, inks for ceramic and metallic effects, among other possibilities.

Through an interview with Salva Bellés, commercial director, we have extracted the following information about how ECOIKN CID was born. He told us that there are still no environmental laws that make the use of water-based technology compulsory, but he believes that it is something that is coming in the not too distant future, this is where Torrecid anticipated the needs of the market and began to investigate whether the use of a technology based on water was possible.

When it comes to management, it is important to emphasise that it is achieved with a reduced number of inks that allows all possible colour combinations, eliminating them, allowing maximum use of the ink and thus avoiding the creation of waste.

In February 2018, it was the launch of this technique that led them to win the "Alfa de Oro" award, one of the most renowned awards in the industry at an international level. And this was not the first award received by this company, as it has several of these, all received thanks to the contributions that Torrecid has made to its sector. (Al-Farben)

We can divide the advantages of this method into two types: technical advantages and environmental advantages. In the following table, both types of advantages of the Ecoikn-Cid solution have been compiled:

Table 3: Technical and environmental advantages of using Ecoink-Cid

Technical advantages	Environmental benefits
Improving the definition of the performance of ceramic colours and their effects	It is an eco-friendly practice
Drying times of the parts are reduced, which makes subsequent applications easier, improving the quality of the print.	It facilitates and improves the management of the waste generated, reducing a large part of it.
Even large formats can be decorated	Reduces emissions caused by the activity
Product finishes are more realistic and natural.	Creates an improvement in the working and production environment.
It is compatible with all other ceramic applications.	It generates a positive behaviour in the company, favouring compliance with emissions legislation and environmental protocols in force.

Source: own elaboration based on data provided by Torrecid.

Next, an investigation has been carried out on the companies that rely on Torrecid as a supplier and that use this water-based solution in their production and therefore also enjoy the above advantages described in the table. According to the information provided by Diego Carratalá, technical assistant at Torrecid, the main companies in the cluster that have incorporated ecoikn-cid into their production processes are:

Table 4: Companies using the Eco-ink solution.

Name of the company	Location	Type of company
Peronda	Onda	Tile Company
Baldocer	Vall d'Alba	Tile Company
Inalco	Alcora	Tile Company

Source: own elaboration with data provided by Torrecid staff.

As Diego told us, at the beginning these entities began to use these inks because they were easy to enamel, as in some procedures they could not do it in the usual way due to the thickness of the pieces and their humidity, which limited a large part of the process. As we have already seen, the alternative offered by Torrecid to traditional inks can be applied to any type of format, regardless of its roughness, size, format or thickness. By starting to use ecoink, they not only offer added value to the customer in terms of differentiation and quality, but also save time in their manufacturing processes.

What we have seen are all points in favour of the use of this solution, but on investigation, we have raised some problems or difficulties that may be encountered in the manufacture and use of this technique.

First of all, it is a water-based ink, so the main problem would be this, the use of water. According to Torrecid, the amount of water used is optimal and it is much more efficient than the materials used by traditional methods. In addition, it is not harmful, unlike traditional methods.

The other problem, or disadvantage in this case, would be the production cost for the company since, as Salva mentioned, it is produced in smaller volumes than the other types of inks, so it is not possible to make use of economies of scale. But sales prices are in the same range as the solvent alternatives, which makes the product competitive, but a lower profit margin is obtained. Moreover, this technology is growing, it is being progressively implemented and in the near future, according to studies carried out by the company, most companies will opt for the use of these inks, which will facilitate production in large quantities and reduce costs.

Now, we will carry out an internal and external analysis (SWOT) to illustrate the above in a more visual way by way of a synthesis.

Table 5: SWOT Matrix of the Eco-Ink solution

WEAKNESSES	THREATS
• Low demand cannot make use of economies of scale • Low profit margin compared to traditional inks • Ignorance of the solution	• Resistance to change • Habitual use of traditional inks • Belief that it is more expensive to be "ecofriendly". • Less restrictive legislation in other areas is a threat to competitiveness, as they have to invest
STRENGTHS	**OPPORTUNITIES**
• Compatibility with all types of printers • Does not use toxic waste pollutants • Offers higher print quality and more variety	• More restrictive environmental legislation • Growing public concern

Source: own elaboration using information provided by Torrecid.

SMART-CID

Within the lines of the company; the continuous search for innovative solutions, new processes and concepts for the consumers of its brand, it has managed to develop a new process, the "Smart-Cid" with which the decoration is achieved on a baked base at a very low temperature compared to traditional methods.

The temperature is between 750 and 850 degrees centigrade, as opposed to the 1350 and 1200 degrees at which they are fired in normal processes. This technique makes it possible to achieve a wide range of colours, while maintaining the tones and textures already present in the bases and curvatures of the original pieces. The level of breakage of the pieces has been reduced by reducing the high levels of heat.

SLIMCID AND SLIMCID FLOOR

Slimcid is the name of an extensive research process that has culminated in the creation of a revolutionary ceramic body. With the help of the technology, the thickness of ceramic floor tiles commonly used in ceramic production processes has been reduced by 50%.

This results in tiles that are about four millimetres thick, achieving energy efficiency in manufacturing, consuming the least amount of natural resources possible and helping to reduce emissions and pollution generated throughout the process. To this must be added the advantages throughout the distribution and storage chain of the product, as by reducing its size and weight, it reduces the amount of transport elements and consumables necessary for transport and optimises space in storage centres.

These tiles are suitable for all types of spaces: ceilings, lattices, facades, furniture, parameters, doors and even in the nautical industry.

From the slimcid line, slimcid floor was born, a flooring solution that provides maximum flexibility and resistance in much lighter pieces than the rest, with a great resistance to impact that adapts to all types of floors, this is its star feature: it can adapt to any type of floor.

6.2 IMPLEMENTATION OF GOOD PRACTICES IN CERAMICS, TORRECID CASE.

Next, once the company Torrecid and its improvement projects have been introduced, we are going to carry out a study based on a document created by the Generalitat Valenciana called "Good Environmental Practices in Ceramics". To do this, we will analyse the proposals made in it, comparing it with those implemented in the entity described and the possible changes or innovations that could be made to achieve total compliance with these practices. All the information detailed below has been extracted from the aforementioned document.

The Generalitat Valenciana presents Best Practices as a simple and inexpensive way to obtain efficient results quickly. They are based on changing the mentality of the people who form part of the companies and the way they organise their operations. As already mentioned, they do not have a high cost, therefore, they are highly profitable and, as they do not affect processes, they are usually accepted positively in most cases (Generalitat Valenciana, nd).

As we have seen above, ceramics is a large industry, with a large presence and importance and with a complex manufacturing process that generates externalities. When we think about correcting this, we can think about reducing or even replacing harmful materials with others, modifying equipment to reduce the consumption of supplies, designing new products that meet environmental expectations, and so on.

The Guide, created by the Generalitat Valenciana, focuses on employers and workers in the ceramics industry to permanently improve the activity of the ceramics sector when it comes to protecting the environment that surrounds it. It includes a series of practical recommendations to achieve environmental efficiency, protecting and improving the environment:

- Cares for the land and facilities on its property, preventing soil contamination.
- Invest in R&D to prevent future pollution and reduce existing pollution.
- It makes its environmental policies public.
- Work with suppliers who supply the least harmful products.

- It invests in the improvement of human resources in environmental management and training to equip its staff with the necessary skills.

- It sees environmental issues as an opportunity for competitive improvement.

The results of applying these recommendations are the reduction of consumption in general and of the waste generated, the minimisation of pollution (atmospheric, acoustic), the creation of competitive advantages that allow a good positioning.

It covers all the steps described above in the process of creating ceramic tiles, from the reception of the necessary raw materials to the packaging, storage and dispatch of the final pieces.

First of all, it is important to remember that Torrecid is not a tile company, but a colorificio that supplies them, therefore, its final product within the company is not the ceramic tiles but the products that it supplies to them so that they reach the final product. The process that follows varies depending on the product. However, we will adapt the recommendations as far as possible.

In order to explain the process, we will briefly explain what it consists of. Its raw materials are minerals, feldspars, quartz, alumina, kaolin, oxides, which, when subjected to a melting or calcination process, give rise to frit and the different inks.

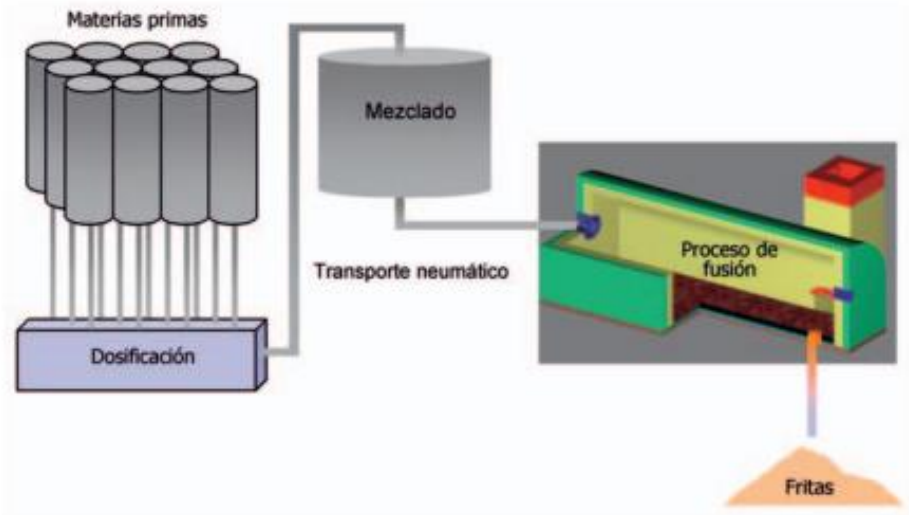
These materials arrive at the company by means of lorries that transport them. Once they have been unloaded, they are classified according to their origin and type of material, then the quality department takes samples of the different types of materials and in the control department they are subjected to different tests and their quality is examined to see if they comply with the necessary characteristics. Once it has been verified that they meet the requirements, they are classified and labelled with a bar code available for reading at any time that will also describe the state of the material. The previous step allows to have a real control of the state of the materials at all times. Once this step is completed, they are ready to start the transformation process.

When it comes to transforming them, the process varies depending on the product: it is not the same for producing an engobe or glaze as it is for producing inks, for example. It is not the same to produce an engobe or glaze as it is to produce inks,

for example (which are obtained by grinding with water to obtain the engobe and glaze) or pigments.

Firstly, frit is the main material used to make glazes and engobes, which are an essential material in the production of tiles. In order to obtain this product, different types of furnaces are used (gas-fired), melting furnaces, function furnaces, electric muffles, mills with alumina balls, etc., all of which consume a great deal of energy. All this consumes a large amount of energy. This material cools rapidly and is transformed into solid material.

Image 5: Ceramic frit manufacturing process



Source: Qualicer

As for ceramic colours or inks, they are basically composed of oxides of periodic elements. They are obtained by complex chemical formulations (Qualicer, 2006).

In terms of pollution, this process creates and emits a large part of particles that are dispersed, contributing to the pollution of the working environment. This process has evolved since its beginnings, thanks to the implementation of purification systems, these particles are located and subjected to periodic self-controls stipulated that comply with the measures established by the Conselleria. the facilities where the loading and unloading of materials and the depulverisation of the transport systems they use take place.

Image 6: Frits during the fusing process

Source: Qualicer

Torrecid, together with the other existing ceramic frits, glazes and colours companies, is committed with ANFFECC to invest in research to improve existing techniques in order to reduce as much as possible the negative externalities of the process (Artola, nd).

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Starting at the beginning of the process, and following the guidelines in the document, we have, first of all, the following:

1. The Generalitat recommends maximising the size of the loads of materials in order to reduce the amount of packaging as far as possible. And in the case of the use of packaging, it is recommended to avoid composite packaging, as this is more complex when it comes to recycling, and where possible the packaging used should be made from materials that have already been recycled or are biodegradable.

   In addition, it is also efficient to test and inspect the materials produced and check that they are in good condition before storing them.

2. Storage The storage should be clean and closed or airtight to avoid loss of properties or contamination due to exposure to air or water, and spaced storage is recommended to make handling or inspection more convenient. In order to avoid accidents at work, the correct storage and labelling of potentially hazardous and noxious substances to be handled is also important. If this is not taken into

account, loss of materials, waste and accidents are likely to occur, leading to additional costs and waste generation.

3. As for the handling: crushing and grinding of the materials, studies should be carried out to see which alternatives are most suitable for each company, depending on the size or specific characteristics of each company, and which is the most efficient option for optimising the process. The machines consume a large amount of energy, and toxic waste such as hydraulic oils from machinery (poor management of this already used oil contributes to 40% of the pollution of our rivers and lakes), and solvents are used. For the latter, it is recommended that they be reused as much as possible, and it is even recommended that a distillation system be installed to recover solvents.

   Wastewater or so-called sewage (depending on the degree of contamination and sludge), if treated in the right way, can be reintroduced into the production cycle and thus achieve zero discharge numbers.

4. Packaging. "In a year, an average of 50 kilograms of plastic is produced per inhabitant. Of this amount, more than half ends up in containers; only 40% is used to package products" Conselleria de Medi Ambient.

   A study of the packaging cycle should be carried out, to see how products are packaged and packaged in order to avoid packaging waste, it is interesting to recover the packaging materials and reuse them as many times as possible, that is why it is important that the materials used to manufacture the packaging are reusable, as single-use packaging becomes useless waste.

5. Logistics, it is important to carry out impeccable maintenance of the facilities, to avoid breakdowns, accidents, leaks, etc. It is advisable to carry out inspections of electricity, machinery, plumbing and to implement rules to avoid situations that could harm workers or companies. Cleanliness in common areas is essential to maintain a clean and safe environment.

6. If a company's daily actions are correct, its environmental impact also becomes positive. If the workers are the ones who keep the company running and are in charge of keeping production going, it is important that they have environmental training. Environmental training days are a practice that is increasingly being

implemented by industries. They aim to raise awareness of the benefits of these practices and some of the measures they propose are as follows:

- Establish environmental accounting.
- Setting targets to reduce waste.
- Contract energy audits.
- Implement solar lighting systems or sodium lamps.
- Install presence detectors to reduce electricity consumption.
- Use rainwater (purified).
- Establishment of measures to prevent wasteful situations.
- Print double-sided to reduce annual paper waste and use recycled paper.

Having seen the previous points, we are going to analyse them from the perspective of the day-to-day running of the Torrecid company with the information gathered from the website and the different interviews carried out with the company's staff:

1. Torrecid mainly receives materials directly from vats and tanks, so it does not generate packaging waste. In addition, they also apply the FIFO system[3], using first the materials or products that have been in the warehouse the longest to prevent them from generating waste or losing their properties. And as we have seen during the process of receiving raw materials, it complies with the recommendations established in the document.

2. This company is very careful with order and cleanliness, it labels the elements and materials with a bar code for later identification and to facilitate order, and it also carries out periodic risk prevention workshops for its workers.

3. Handling and production: It has "Vulkano" kilns, part of a project that aims to boost the energy and environmental efficiency of kilns, currently this innovative solution is implemented in only two countries: in the steel sector in Slovenia and in the ceramics sector in Spain (Circe, 2017). The main concern, in this case, would be that the production of frits and glazes requires the application of high temperature in the kilns and the application of an intense and continuous energy

[3] FIFO: First In First Out, is a storage system in which the materials that have entered first are consumed first.

source. This results in emissions of combustible products, and oxidation of atmospheric nitrogen caused by the high temperatures. On particulate emissions from processes such as transport, loading and unloading.

One of Torrecid's main concerns has been to find a solution to this problem, as it creates an unpleasant working environment. For this reason, the company has closed facilities, vacuuming and dedusting processes. In its production plant, there are de-spraying and particle absorption machines to create a clean environment in the processes that generate the most dust, such as during mill cleaning or frit melting, among others. Their production processes need water, therefore, they also generate large quantities of waste water. This is recycled and sent to other soil atomising companies to be used in their production process, so that it is used again in the same production cycle. Specifically, Torrecid has installed large pipes that carry this water to an atomiser located next door. In this way, the water is reused for the process of atomising the soil that will later be used in the tile factories, where the tile production process will begin.

4. The company conducts routine weekly checks of its facilities and storage products for performance and quality. It uses recyclable packaging that can also be reused.

5. As far as cleaning is concerned, an external company is contracted to take care of this on a daily basis.

6. Finally, it focuses on ensuring that its employees are trained and attuned to the company's values and beliefs so that they can apply them in their daily work. In addition, for the last couple of years it has been working to reduce paper waste as much as possible by promoting electronic communications internally. It regularly holds seminars and training courses for its staff.

Below, a table has been created to summarise the above information. This table illustrates the different phases of the process and the measures to be carried out according to the Good Practices document and assesses whether or not they are complied with from Torrecid's point of view:

Table 6: Comparison of Good Practices in Ceramics with the company Torrecid

PROCESS	GOOD PRACTICE	TORRECID
Reception and sorting	• Recovery and reduction of packaging use • Product quality control • Efficient sorting	✓
Storage	• Clean facilities • Labelling of different types of materials • Accident prevention	✓
Manipulation	• Debugging and management of waste • Machinery suitable for environmental suitability	✓
Packaging	• Packaging materials suitable for reuse and/or recycling	✓
Logistics	• Periodic maintenance of installations and machinery to check that they are working properly. • Neat and clean areas	✓
Training	• Workers trained and aware of current environmental regulations.	✓

Based on the above analysis and with the visual aid of the table, we can conclude that Torrecid carries out a process that is totally committed to the environment and to the environment and the staff that form part of the company.

6.3 FUTURE CHALLENGES FACING TORRECID

As we have seen, throughout the development of the ceramics industry, new environmental laws have been created or existing ones have been modified according

to the problems faced by the environment. To this we must add the rapid growth of the industry thanks to technological advances, which allow processes to be made more dynamic and optimised, and also the rapid obsolescence of these processes.

We addressed the issue of the water-based ink solution, Ecoink, as Torrecid workers explained to us, with these new green lines they cannot yet apply the use of economies of scale, as they are alternatives that are not yet established in the production processes of other companies, either because of resistance to change or ignorance of these technologies, since we have already seen that the price was not very different from the price of traditional solutions. (Torrecid,

For this reason, one of the main challenges facing our company is to position its green product lines in the minds of consumers (in this case, tile companies) and to eliminate the reticence that environmentally committed or ecological products are much more expensive than the rest.

It faces a very important challenge, which is to keep its staff well trained not only in the professional field but also in the environmental field, it is important that its employees are up to date with the current regulations regarding pollution and above all, that they are aware of the importance of this practice in all the tasks they carry out in the company, even in small things such as reusing paper or using recyclable cups instead of the traditional water cups, avoiding plastic bottles, etc. This issue can be aversive for older workers, as they are used to doing their work in the traditional way and generally find it more difficult to adopt new ways of working.

Throughout the work, it has been mentioned that in other countries where environmental laws are less strict or even non-existent, the companies' production plants are installed, trying to lower their costs, pay less "green" taxes and thus reduce competition with the rest of the companies, leaving no room for concern for the natural environment. It is important that end consumers, such as builders or people looking for tiles and flooring for their homes, are aware of who are the companies that really care about the conservation of the environment. So, it would be quite interesting for our company to invest in advertising to end consumers so that they get information, as this is an issue that society is increasingly interested in and can be a decisive factor in the choice of one company or another.

Competition is quite a relevant issue in the sector, which in many cases has benefited some companies (Fundacion Bancaja, 1999), allowing them to change their structure from small and medium-sized family businesses to large multinational companies and groups, as in the case of Porcelanosa or Alaplana.

The strong competition in the sector can be beneficial for Torrecid, as it can focus on working on and improving its differentiation strategy by opting for "green differentiation", which will benefit it in terms of obtaining subsidies and grants to research or implement new processes and products that do not pollute.

7. CONCLUSIONS

Since the beginning of production, concern about the depletion of production factors (such as water, land, oil, gas) has grown as industry has developed. This concern has had its positive side, as it has given rise to research to develop renewable elements that can replace them.

Another major concern linked to the previous one is the deterioration of the environment in general, but especially the environment located in and around the production plants, due to the generation of waste, water discharges, gas emissions, the use of harmful elements, noise pollution, among others.

The laws and taxes that regulate this issue are a great inconvenience when it comes to production for some companies, but for others, they serve as an impetus to improve and try to reduce their negative externalities as much as possible. An example of this is the practice of eco-design, among other modalities.

One large industry that is affected by all of the above is the ceramics industry, a very consolidated and prestigious sector whose cluster is located in our province as we have already seen. This cluster is very well positioned in the foreign market, contributes to the creation of a large number of local jobs, stimulates the economy of the area and generates income and wealth, among other positive characteristics as we have seen throughout the work.

Looking at it from a more global point of view, the ceramics industry in general is faced with the challenge of minimising pollution, spillage, waste or residues. This is an obligation it has to the natural environment, but also to its workers, as they are the ones who work close to all the pollution generated and are exposed to toxic raw materials, humidity and harmful gases.

Therefore, there are ceramic companies that approach this issue from a social point of view and not as an imposition. These companies are increasingly committed to R&D&I and to providing a higher quality product with greater added value. One of these companies is Torrecid, which, as we have studied, focuses its efforts on transforming its negative externalities into positive ones through its professional staff.

Torrecid is a successful and increasingly valued entity in the national and international market. Its innovation and differentiation strategies have positioned it in a positive way in the minds of its customers and also in society.

Thus, it has shown that a company that focuses on production that respects environmental laws, takes care to recycle and reuse, among other things, can produce a product of the highest quality with the least possible damage to the environment. This can serve as a model for the many companies that are not yet aware or focus only on production.

By way of reflection, as is happening in the ceramics industry, it is happening in other companies and industries such as the textile, automobile, food, etcetera. In general, if the main industries focus on joining forces and reducing all those processes and the use of harmful products, they will be a great example for consumers as a whole and will benefit the environment, contributing to the concern for environmental conservation and the practices of reuse and recycling.

8. LIST OF REFERENCES

- Abaleo (2017). ¿Qué es ecodiseño? [online] Abaleo Factoria de Soluciones Ambientales. Available at < https://abaleo.es/que-es-ecodiseno/ > [Accessed 1 june 2021]

- Actualidad Empresa (2014). Clúster: Definición, objetivo, beneficios y desarrollo. [online] Actualidad Empresa. Available at: http://actualidadempresa.com/cluster-definicion-objetivo-beneficios-y-desarrollo/ [Accessed 2 March 2021]

- Aenor (2021). Certificación ISO 14006 gestión del eco diseño. [online] Aenor confía. Available at: <https://www.aenor.com/certificacion/medio-ambiente/ecodiseno> [Accessed 9 March 2021]

- Aguilera, J (2016). La importancia de los clúster. [online] V AT Clusters Conference – III Congreso Español de Clusters. Available at: <https://www.youtube.com/watch?v=Cy14EXwLthQ> [Accessed 20 March 2021]

- Albors-Garrigos, J., & Hervás-Oliver, J. L. (2012): Radical Innovation and Technology Diffusion in Traditional clusters: how high-tech industries reinvented traditional clusters, In TG Bas and J. Comparing High Technology Firms in Developed and Developing Countries: Cluster Growth Initiatives, p.99-110. [Accesed 2 March 2021]

- Anffecc (2010). Empresas. [online] Asociación Nacional de Fabricantes de Fritas, Esmaltes y Colores Cerámicos. Available at < https://www.anffecc.com/es/empresas > [Accessed 25 April 2021]

- Artola, M (nd). Legislación ambiental aplicable al sector Vidrio-Cerámica: Situación actual y tendencias. [online] Boletín de la Sociedad Española de Cerámica y Vidrio, Dossier. Available at: <http://boletines.secv.es/upload/20080512114901.47[2]57-80.pdf > [Accessed 5 May 2021]

- Ascer (2019). Descripción del sector. [online] Asociación Española de Fabricantes de Azulejos y Pavimentos Cerámicos. Available at: <https://www.ascer.es/sectorPlantilla.aspx?lang=es-ES&cual=descripcion> [Accessed 1 June 2021]

- Ascer (2020). Datos estadísticos, información económica, sector competitivo. [online] Asociación Española de Fabricantes de Azulejos y Pavimentos Cerámicos. Available at: < https://www.ascer.es/sectorDatos.aspx?lang=es-ES > [Accessed 20 February 2021]

- Baigorri, P (2004). La industria española de esmaltes: la nueva revolución, Téc. cerám., 326, 908-18. [Accessed 2 June 2021]

- Barron, M (2017). Hollywood, el cluster de los estudios y la industria del cine. [online] Estudios de sistemas. Available at < http://marianabarron24c.blogspot.com/ > [Accessed 5 june 2021]
- Business Planet (2021). How business clusters drive innovation. [online]. Eurooean Commission. Available at: < https://ec.europa.eu/growth/content/business-planet-how-business-clusters-drive-innovation_es > [Accessed 12 April 2021]

- Castellón Plaza (2019). El clúster cerámico en la Comunidad Valenciana. [online] Castellón Plaza. Available at: <https://castellonplaza.com/el-cluster-ceramico-5500-millones-de-facturacion-el-8-de-la-produccion-industrial-de-la-comunitat> [Accessed 7 April 2021]

- Cavala (2014). Codigo de conducta: Principios del buen hacer empresarial. [online] Responsabilidad Social Corporativa. Available at: <https://responsabilidad-social-corporativa.com/el-codigo-de-conducta-principios-del-buen-hacer-empresarial/> [Accessed 1 June 2021]

- Cerem Comunicación (2016). Impacto ambiental del sector cerámico. [online] Cerem International Business School. Available at: <
- https://www.cerem.es/blog/impacto-ambiental-del-sector ceramico#:~:text=Emissions%20in%20the%20production%20of%20cer%20C3%A1mics&text=The%20high%20volume%20of%20emissions%20in%20the%20process%20of%20production%20of%20C3%B3n > [Accessed 6 April 2021]

- Circe (2017). Torrecid abre sus instalaciones para demostrar el funcionamiento de los hornos desarrollados en el proyecto Vulkano. [online] Cierce. Available at: https://www.fcirce.es/eficiencia-energetica-es/torrecid-abre-sus-instalaciones-para-demostrar-el-funcionamiento-de-los-hornos-desarrollados-en-el-proyecto-vulkano [Accessed 5 June 2021]

- Fundación Bancaja (1999). El Clúster cerámico en Castellón: iniciativa de refuerzo de la competitividad, Bancaja, Valencia. [Accessed 2 June 2021]

- Generalitat Valenciana (n.d). Las buenas prácticas medioambientales en la Cerámica. [doccument] Available at: <https://www.cma.gva.es/areas/educacion/educacion_ambiental/educ/ed_amb_empresa/pdf/ceramicaC.PDF > [Accessed 12 March 2021]

- Generalitat Valenciana (nd). Las buenas prácticas medioambientales en la Cerámica. [online] Generalitat Valenciana, Conselleria de Medi Ambient. Available at: https://www.cma.gva.es/areas/educacion/educacion_ambiental/educ/ed_amb_empresa/pdf/ceramicaC.PDF [Accesed 25 February 2021]
- Gouardères, F. (2021) Los principios Generales de la política industrial de la Unión. [online] Parlamento Europeo. Available at: https://www.europarl.europa.eu/factsheets/es/sheet/61/los-principios-generales-de-la-politica-industrial-de-la-union [Accessed 1 June 2021]

- Iberdrola (2021). Eco diseño: como realizar productos sostenibles y satisfacer al consumidor. [online] Iberdrola, compromiso social, eco diseño. Available at: <https://www.iberdrola.com/compromiso-social/ecodiseno-productos-sostenibles> [Accessed 28 March 2021]
- Imago-mol (2020) About us [online] Imago-mol. Available at: < https://www.imago-mol.ro/about-us/?lang=en > [Accessed 23 February 2021]

- Inkcid (2021). Inkcid, The solution. [online]. Torrecid Group. Available at: https://www.inkcid.com/es/ [Accessed 2 April 2021]

- Lumiber (n.d). La importancia del medio ambiente en las empresas. [online] Lumiber Sevilla. Available at: < https://www.lumiber.com/medio-ambiente-en-las-empresas/ > [Accessed 10 March 2021]

- Mihai, C. (2020). El interés de formar parte de un clúster como es el caso de Imago-mol [online]. Euronews. Available at < https://es.euronews.com/next/2021/03/12/el-interes-de-formar-parte-de-un-cluster-como-es-el-caso-de-imago-mol > [Accessed 25 March 2021]

- Ministerio de Medio Ambiente y Medio Rural y Marino (2011). Mejores Tecnicas Disponibles de referencia europea, Sector de la fabricación ceramica. [online] Serie Prevención y Control Integrados de la Contaminación (IPPC). Available at: < https://prtr-es.es/Data/images/MTD_Ceramica_ES.pdf > [Accessed 2 April 2021]

- Molina-Morales, F. X. (2002): "Industrial districts and innovation: the case of the Spanish ceramic tiles industry", Entrepreneurship & Regional Development, nº14(4) p.317-335. [Accessed 2 March 2021]

- Monografías (nd). Clúster cinematográfico Hollywood. [online]. Monografías Plus. Available at: <https://www.monografias.com/docs/Cl%C3%BAster-cinematogr%C3%A1fico-Hollywood-PKN7BYZBZ > [Accessed 5 May 2021]

- Novo, A (2015). La importancia de los clusters. [online] V AT Clusters Conference – III Congreso Español de Clusters. Available at: <https://www.youtube.com/watch?v=Cy14EXwLthQ> [Accessed 20 March 2021]

- Pitarch, M (2018). La industria cerámica echa el freno y prevé un 2019 sin crecimiento. [online] El País. Available at: https://elpais.com/ccaa/2018/12/16/valencia/1544982672_225628.html [Accessed 4 April 2021]

- Porter, M. E. (1999) Clusters and Competicion: New Agendas for Companies, Governments, and Institutions. Harvard Business School Press.

- Porter, M. E. (2000). Location, Competition, and Economic Development; Local Clusters in a Global Economy. [online] The Economic Competitiveness Group. Available at: <http://www.ecgroup.com/methodology/cluster.htm> [Accessed 27 February 2021]

- Practical Team (nd). Clúster: Definición, objetivos y aspectos fundamentales de esta herramienta competitiva. [online]. Expansión, crecimiento e internacionalización empresarial. Available at: <https://www.practicalteam.com/blog/cluster-definicion-objetivos-y-aspectos-fundamentales-de-esta-herramienta-competitiva/ > [Accesed 3 May 2021]

- Qualicer (2006). La fabricación de fritas, esmaltes y colores cerámicos. Retos sociales, económicos y medioambientales en el contexto internacional. [online]. Qualicer. Available at: < https://www.qualicer.org/recopilatorio/ponencias/pdfs/0611010s.pdf> [Accessed 7 May 2021]

- Querelle y Cia (2015). Contaminación industrial. [online] Profesor en línea. Available at: <https://www.profesorenlinea.cl/ecologiaambiente/Contaminacion_industrial.htm> [Accessed 5 June 2021]

- Redacción APD, (2019). ¿Qué es un clùster empresarial y cuáles son sus objetivos? [online] APD. Available at: <https://www.apd.es/que-es-un-cluster-empresarial/> [Accessed 27 February 2021]

- Retema (2015). El reto de reducir la contaminación industrial. [online] Revista Tecnica de Medioambiente. Available at: < https://www.retema.es/noticia/el-reto-de-reducir-la-contaminacion-industrial-iQod > [Accessed 1 May 2021]

- Reyes, J. (nd). Cerámica Industrial: Producción de Pavimento y Revestimiento Cerámico. online] Departamento de Ingeniería Química, Universidad de Alicante, Facultad de Ciencias. Available at: https://rua.ua.es/dspace/bitstream/10045/13558/1/CeramInd_JARLIQUA.pdf [Accessed 5 June 2021]

- Rodríguez, E. (2020). Que es un cluster empresarial y cuáles son sus beneficios. [online]. Seoestudios. Available at: <https://www.seoestudios.es/blog/que-es-un-cluser-empresarial/> [Accessed 27 February 2021]

- Somoza, D (2020). Clústeres: más allá de Silicon Valley. [online] El Nacional. Available at: https://www.elnacional.com/opinion/clusteres-mas-alla-de-silicon-valley/ [Accessed 5 May 2021]

- Terrada, A (nd). Estudio del sector cerámico en la Comunidad Valenciana. [online] Universidad Politécnica de Valencia. Available at: <https://riunet.upv.es/bitstream/handle/10251/14599/Alba%20Terrada%20Rubio.pdf;sequence=1> [Accessed 10 April 2021]

- Torrecid (2021). Torrecid empresa. [online] Torrecid. Available at: http://www.torrecid.com/es/torrecid-empresa/ [Accessed 4 May 2021]

- Up Spain (nd). Cluster Empresarial. Que es y cuales son sus objetivos. [online] Blog Up Spain. Available at: <https://www.up-spain.com/blog/cluster-empresarial/ > [Accessed 5 April 2021]

9. BIBLIOGRAPHY

- Online email interview with Salva Bellés, Sales Director and Marketing Department at Torrecid.

- Telematic interview via google meet with Diego Carratalá, Technical Assistant at Torrecid

- D. Gabaldón, E. Tortajada, I. Fernández (2008). El papel de las fritas, colores y esmaltes en la evolución del sector cerámico de la Comunidad Valenciana, Presidencia de la Generalitat Valenciana, Fundación Premios Rey Don Jaime I, Valencia.

- Visit to the production plants in the ceramic company Azteca Cerámica (Alcora, Castellón), to see the ceramic manufacturing process.

- Information provided during the visit to Azteca Cerámica by Mayte Cano, Director of the Development Laboratory of Azteca Cerámica.

- ASCER (2011). Internal report. Castellón.

- Hervas-Oliver, J.L. (director); Boronat-Moll, C.; Sempere-Ripoll, F; Estelles-Miguel, S. (2018) Plan Sectorial del Cluster Cerámico, Plan Estratégico de la Industria Valenciana, Conselleria de Economia Sostenible, Sectores Productivos, Comercio y Trabajo, Dirección General de Industria y Energía, Generalitat Valenciana. Valencia.

- López, G (2003). Frits, glazes and colours. Internal competition and external expansion, Alimarket Constr. Materials Report, 44-49.