

THE MANUFACTURE OF FRITS, GLAZES AND CERAMIC COLOURS. SOCIAL, ECONOMIC AND ENVIRONMENTAL CHALLENGES IN THE INTERNATIONAL CONTEXT



MR. Carlos Gonzalvo Lucas ⁽¹⁾ Dr. Manuel Irún Molina ⁽²⁾

⁽¹⁾ President of the National Association of Frit, Glaze and Ceramic Colour Manufacturers (ANFFECC)

⁽²⁾ Head of the area for Sustainable Development, Environment and Energy of the Valencia Region Foundation
European Region, Brussels (Belgium)

Carlos Gonzalvo Lucas , trained as a Ceramic Technician, always closely bound to the ceramic industry, has delivered different courses delving into issues relating to Business Administration and Quality Systems throughout his wide-ranging professional career.

After performing various technical and commercial activities in the field of frits, glazes and ceramic colours, in 1988 he became General Manager at Vernís , S.A. , where he led the firm's internationalisation.

He is currently a member of the Executive Committee of the Castellón Chamber of Commerce, is on the board of directors of the Federation of Business Organisations of the Valencia Region, and is a member of the Council of the Ceramic Industry Research Association (AICE) and of the Organising Committee of the Cevisama trade fair. Since the end of 2002, he has been Chairman of the Spanish National Association of Frit, Glaze and Ceramic Colour Manufacturers (ANFFECC), where he has been the driving force behind the analysis of new strategies that enable the member companies successfully to address the new social economic and environmental challenges arising in the international context.

Manuel Irún Molina earned his Ph.D. in Chemical Sciences from the University of Castellón. He is currently environment and energy officer of the Foundation Valencia Region – European Region in Brussels and environmental project coordinator at the Spanish National Association of Frit, Glaze and Ceramic Colour Manufacturers (ANFFECC), with which he has collaborated since 1998.

ABSTRACT

The present paper sets out noteworthy data and information on the present and future situation of the frit, glaze and ceramic colour manufacturing sector, and outlines the main social, economic and environmental challenges in the international context, with direct implications at EU, Spanish State and, in particular, Valencia Region levels, especially in relation to Castellón province.

The frit, glaze and ceramic colour manufacturing sector has been immersed in this social and business evolution for many years, an evolution which, while fostering the development of the socioeconomic environment, has simultaneously led to increasing concern for our environment, in the frame of what is known worldwide as sustainable development. As a result of this dynamics, the National Association of Frit, Glaze and Ceramic Colour Manufacturers (ANFFECC) has actively participated in the adoption of voluntary agreements with the Administration for compliance and monitoring of the new demands and the targets set.

On a Regional level, an agreement of a voluntary character was signed in 2003 between the ANFFECC member companies and the Department for Territory and Housing of the Generalitat Valenciana (Autonomous Government of the Valencia Region), whose competences include Environmental Affairs in the Valencia Region, to adapt to the European requirements of Directive 96/61/CE on Integrated Pollution Prevention and Control (IPPC), far ahead of the 2007 deadline set for this regulation. Similarly in 2003, another voluntary agreement was signed with the Department for Territory and Housing of the Generalitat Valenciana, which established the system of deposit, take-back and return of re-usable packagings for the Ceramic Industry.

In the EU context, in 2005, ANFFECC signed a collaboration agreement with the Generalitat Valenciana, through the Valencia Region Foundation – European Region, aimed at supporting the actions of ANFFECC on a European level and disseminating internationally that ceramic frits are a product of a glassy nature, owing to the characteristics of their manufacturing process and the end product itself, in accordance with Directive 96/61/CE on Integrated Pollution Prevention and Control (IPPC) and successive regulations.

All these activities have resulted from monitoring the information generated on a national level, mainly by the Ministry for Industry, the Ministry for the Environment and the Ministry of Health, the competent authorities for transactions with the European institutions regarding the position of the sector, for the drafting and future review of the reference documents on glass and inorganic chemical specialties, as well as from the conclusions of the risk evaluation study on ceramic frits, in which the findings of the ecotoxicity and toxicity tests have demonstrated that ceramic frits have no toxic effect, therefore making it unnecessary for them to be assigned any risk notation. This has been important in regard to the adoption process of the Communication by the European Commission of 29 October 2003 on chemical products, with a proposal for the Regulation of the European Parliament and of the Council regarding the registration, evaluation, authorisation and restriction of chemical substances and preparations (REACH), by which the European Agency of Chemical Substances and

Preparations was created, and the proposal of the Directive of the European Parliament and of the Council by which Directive 67/548/CEE of the Council was amended, adapting it to the Regulation (CE) of the European Parliament and of the Council regarding the registration, evaluation, authorisation and restriction of chemical substances and preparations.

These considerations are also important in relation to the transport, classification and labelling of ceramic frits and their wastes, since they should be excluded from the field of ADR transport and dangerous waste management.

In short, the challenge of sustainability for the frit, glaze and ceramic colour manufacturing sector as a commitment to social, environmental and enterprise responsibility involves the integration and management of the existing information with the competent institutions, and the international dissemination of the efforts made in R&D+i (innovation) in relation to the environment, energy efficiency and product classification, as well as to the investments made in technological and environmental fields by the frit, glaze and ceramic colour sector.

1. THE MANUFACTURE OF FRITS, GLAZES AND CERAMIC COLOURS

Ceramic frits are obtained by fusing raw materials in a melting kiln at high temperature (1350 °C – 1550 °C). The melt is cooled quickly, either by a laminating process or by quenching in water, which transforms it into a fragmented solid that is practically insoluble in water and in the most commonly used acids and bases.

The most important group of compounds that give rise to glasses is that of the oxides, since these include the main glass formers of technical and industrial interest, as is the case of ceramic frits, in which the main oxides are SiO_2 and the B_2O_3 . These have the ability not only to form glasses separately, but also, when they are mixed with many other metallic oxides, such as the alkalines, alkaline earths and alumina, which by themselves are not able to reach the glassy state, to react with these and form a continuous glassy phase.

The diagram in Figure 1 schematically illustrates the ceramic frit production process.

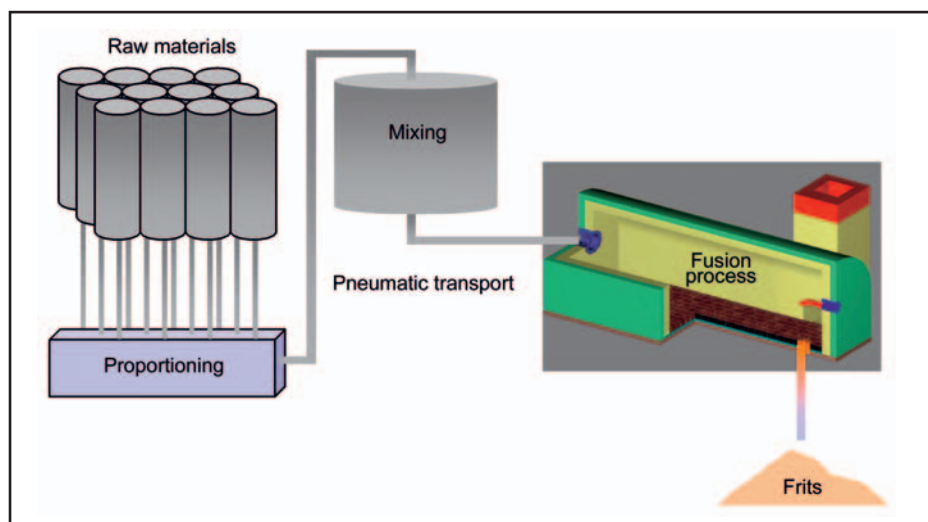


Figure 1. Scheme of the ceramic frit fabrication process.

On the other hand, in the European Inventory of Existing Commercial Chemical Substances (EINECS) ceramic frits are described under No. EINECS 266-047-6, and in the Information Service on Chemical Substances (CAS) of the American Chemical Society under No. CAS 65997-18-4, they are defined as 'a mixture of inorganic chemical substances produced by rapidly quenching a molten, complex combination of materials, confining the chemical substances thus manufactured as non-migratory components of glassy solid flakes or granules'.

Ceramic frits are used as raw materials in elaborating ceramic glazes. Ceramic glazes can be applied either dry or wet in the ceramic tile manufacturing process, although the wet application predominates.

There are different types of glazes, in terms of their physical state and form of packaging, and a great part of the frits produced are used in the formulation of compositions, mixed in proportioning facilities with other non-fritted raw materials, additives and ceramic colours.

The composition raw materials include clays, alumina, zirconium compounds, bentonite, dolomite, quartzes, kaolins, corundums, feldspars, nepheline and metallic oxides (of titanium, iron, zinc, manganese, nickel, cerium, vanadium, etc.). Additives are substances that are added so that the glaze, after milling, will have the appropriate rheological stability and properties (density, viscosity) for its intended application. Additives include different glues (acrylic polymers or cellulose derivatives), common salt, preservatives (bactericide) and deflocculants (sodium phosphates).

Once formulated, the compositions can be sent as such to the client, bagged in solid form, or destined for a wet milling process in the own installations, obtaining aqueous glaze suspensions by milling the compositions with water in ball mills. In this case, a liquid product is involved, although of relatively high density and viscosity.

The main characteristic of these compositions is their insolubility in water and in those acids and bases with which there may be usual contact, due to the use of frits in their formulation. As commented previously, frits are a glassy material whose properties differ from the starting raw materials used.

After these glazes have been applied onto the ceramic bodies, and after the firing stage, they contribute qualities of scratch resistance or resistance to wear in use, impermeability, mechanical strength, as well as the suitability to produce certain decorative effects with a wide variety of colours.

In this sense, ceramic colours are made up of oxides of different elements (aluminium, antimony, cadmium, zinc, cobalt, chromium, tin, iron, manganese, nickel, silicon, vanadium, etc.) in the form of complex structures.

The ceramic colours that are used are also insoluble, and are made up of fine solid particles, which are physically and chemically stable, non-modifiable by the vehicle or substrate into which they are incorporated. They can be classified in different categories depending on their use as colorants or other functions.

Glazes and ceramic colours are the main components of the different coatings applied to ceramic tiles, as schematically depicted in Figure 2. The body is the clayey base of the ceramic tile, while the engobe serves as a coating that facilitates the body-

glaze fit. Subsequent coatings, produced by screen printing and pulverised decorations, involve the use of certain types of glazes for specific decorative applications; these glazes are almost always obtained by injection and spraying of a slip into a stream of hot air, followed by size grading of the resulting solid glaze particles

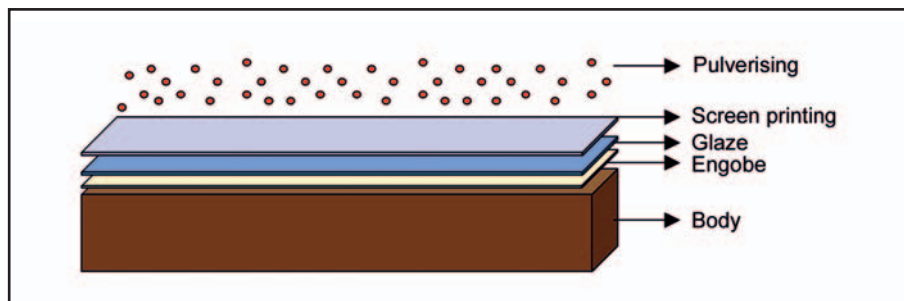


Figure 2. Different layers and surfaces making up a ceramic tile.

2. SOCIAL CHALLENGES ON AN INTERNATIONAL LEVEL OF THE FRIT, GLAZE AND CERAMIC COLOUR MANUFACTURING SECTOR

An indicator of the importance of the Spanish frit, glaze and ceramic colour manufacturing sector is the evolution in personnel hiring, featuring a high percentage of university graduates, which has risen steadily during the last twenty years, as shown in Figure 3.

Over 3,600 workers are directly employed in this sector in Spain, while the ceramic frit industry has been a key driver of the concentration of the Ceramic Industry in Castellón province, which provides direct employment in the ceramic tile sector for over 25,000 people and has a great relevance owing to the geographic concentration of this production sector.

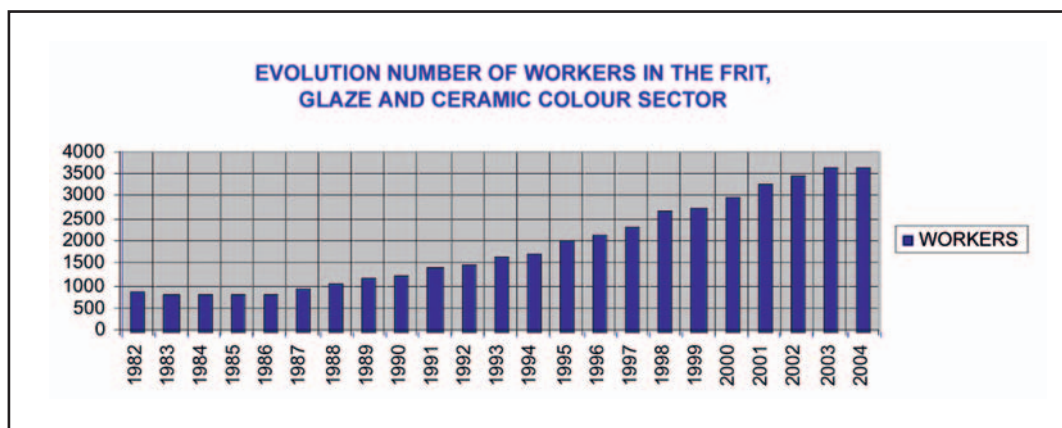


Figure 3. Ceramic evolution of personnel hiring in the frit, glaze and ceramic colour sector in Spain.

The manufacture of Frits, Glazes and Ceramic Colours in the EU takes place in more than 40 facilities, the majority of which are located in Spain and Italy. Production in the EU is estimated at between 1 and 1.25 million tons per annum. In this sense, until a few years ago it could be stated that the EU was the world's top producer of

these products. However, in spite of the lack of rigorous statistical data in certain countries or particular geographic areas, the spectacular increase of Asian markets, specially China, no longer enables us state to categorically that the EU is nowadays the world's top producer.

Table I sets out the distribution of the frit-producing facilities in the EU Member States. However, it may be noted that over 70 % of EU frit production is concentrated in Spain, mainly in the Valencia Region, specifically in Castellón province.

Member state	No. of facilities
Spain	21
Italy	9
Portugal	1
Belgium	1
Germany	4
Holland	1
Great Britain	4
Polond	1
TOTAL	42 (estimated)

Table I. Distribution of the frit-producing facilities in the EU Member States.

The main frit, glaze and ceramic colour manufacturing companies, members of ANFFECC, in Spain are listed in Table II.

COMPANY	LOCATION
ALFARBEN, S.A.	ALCORA (CASTELLÓN)
CERFRIT, S.A.	NULES (CASTELLÓN)
COLOR ESMALT, S.A.	LA FOYA ALCORA (CASTELLÓN)
COLORES CERÁMICOS, S.A	ONDA (CASTELLÓN)
COLORES CERÁMICOS DE TORTOSA, S.A.	TORTOSA (TARRAGONA)
COLORES CERAMICOS ELCOM, S.L.	MANISES (VALENCIA)
COLORES CERÁMICOS LA HUERTA, S.L.	MANISES (VALENCIA)
COLORIFICIO CERÁMICO BONET, S.A	RIBESALBES (CASTELLÓN)
COLOROBIA ESPAÑA, S.A.	VILLAFAMÉS (CASTELLÓN)
COLORONDA, S.A.	ONDA (CASTELLÓN)
ESMALTUR, S.A.	SAN JUAN DE MORÓ (CASTELLÓN)
ESMALGLASS, S.A.	VILLARREAL (CASTELLÓN)
ESMALTES, S.A.	ALCORA (CASTELLÓN)
FERRO SPAIN, S.A.	ALMAZORA (CASTELLÓN)
FRITTA, S.L.	ONDA (CASTELLÓN)
ITACA, S.A.	LA POBLA TORNESA (CASTELLÓN)
JONHSON MATTHEY CERAMICS, S.A.	CASTELLÓN
PEMCO ESMALTES, S.A	VITORIA

PRODESCO, S.L.	MANISES (VALENCIA)
QUIMICER, S.A.	ONDA (CASTELLÓN)
TORRECID, S.A.	ALCORA (CASTELLÓN)
VERNÍS, S.A.	ONDA (CASTELLÓN)
VIDRES, S.A.	VILLARREAL (CASTELLÓN)
VITRICOL, S.A.	ONDA (CASTELLÓN)
WENDEL EMAIL IBERICA, S.A.	NULES (CASTELLÓN)

Table II. Main frit, glaze and ceramic colour manufacturing companies, members of ANFFECC, in Spain

In turn, the corresponding Italian industry is concentrated in the Emilia Romagna Region, coinciding, as in the case of Spain, with a leading EU region in ceramic tile manufacture. Figure 4 shows the territorial distribution of the facilities in the different EU Member States, while Figure 5 displays the regional distribution of the different frit, glaze and ceramic colour companies in Spain

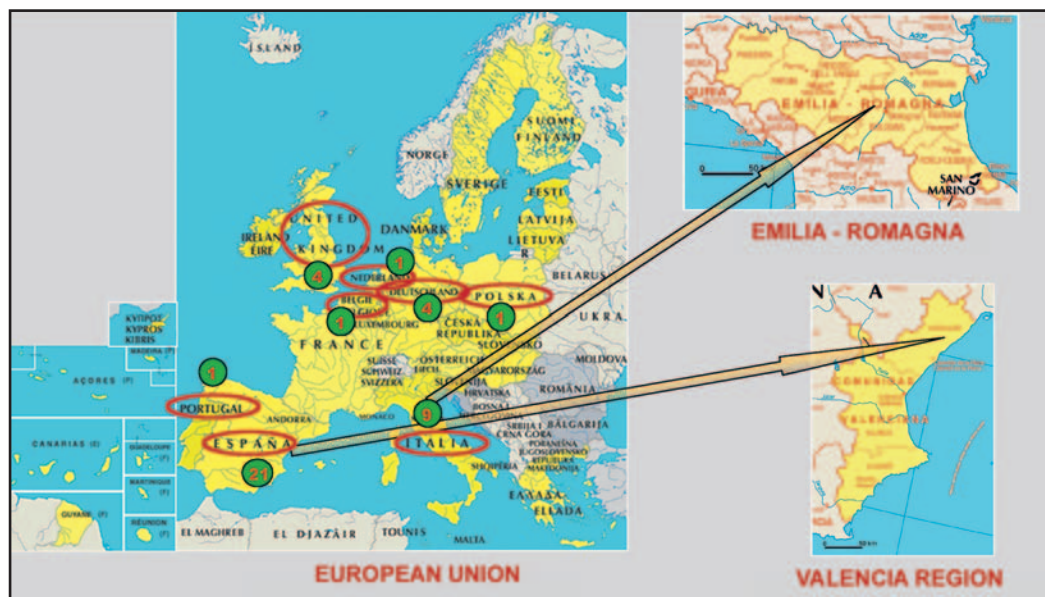


Figure 4. - Territorial distribution of the frit, glaze and ceramic colour manufacturing facilities in the different EU Member States



Figure 5. - Distribution of the frit, glaze and ceramic colour manufacturing facilities in Spain

However, although it is still an important industry in the European Union, nobody is unaware of the changes that the socioeconomic environment is undergoing. With the increasingly stringent demands of new regulations, the companies in the Member States must adapt to the new demands of the global market, following the new business tendencies, influenced by a great number of factors. The influence of economic aspects is linked to technological, environmental, regulatory and social issues, producing a new working scenario that defines the present context and can largely condition the future situation.

3. ECONOMIC AND ENVIRONMENTAL EVOLUTION OF THE SECTOR IN THE INTERNATIONAL CONTEXT. RESEARCH, DEVELOPMENT AND INNOVATION, BASIC PILLARS FOR THE SUSTAINABILITY OF THE FRIT, GLAZE AND CERAMIC COLOUR SECTOR

It should be noted that, indeed, production volume has increased considerably and Spain has displayed important sales growth in recent years. However, there is strong international commercial competition with countries from outside the EU. Although a great amount of the ceramic frits produced in Spain are consumed internally in the EU, countries outside the EU are also an important market for ceramic frit exports.

The graph in Figure 6 shows that more than 50% of the ceramic frits produced in Spain go to exports, and are a key raw material in the ceramic tile manufacturing sector.

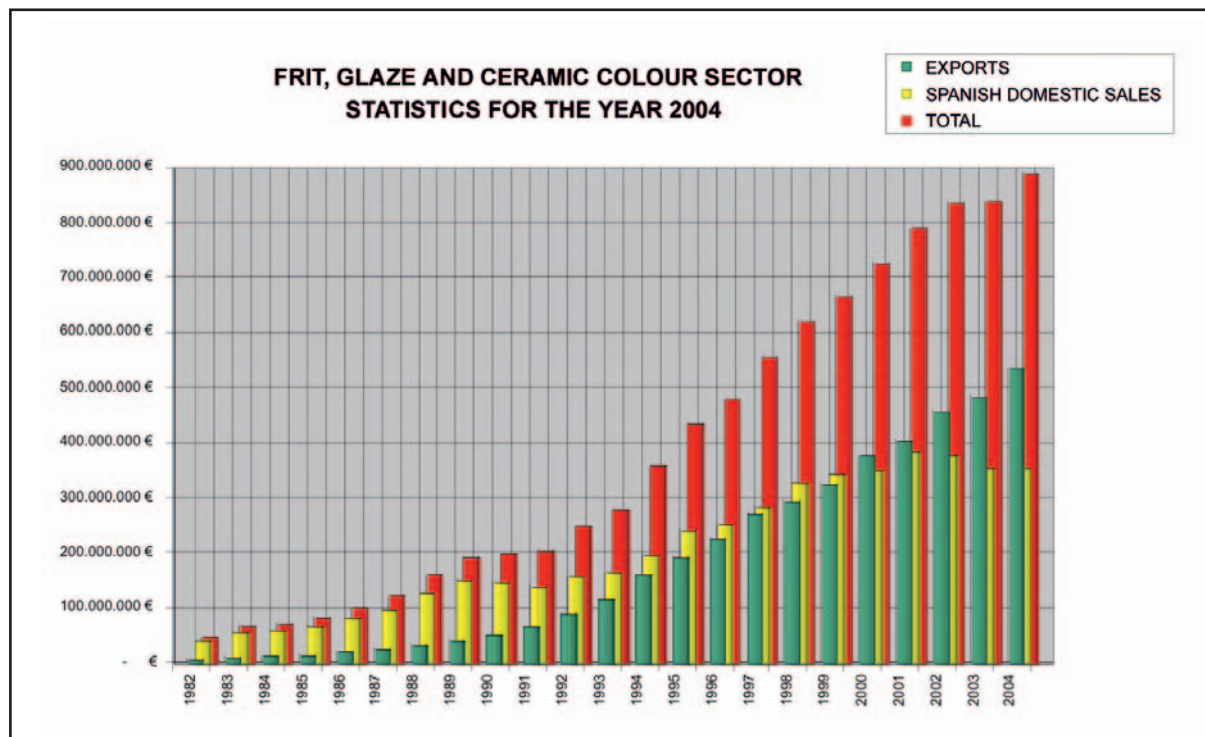


Figure 6. Evolution of the frit, glaze and ceramic colour sector in Spain (Source ANFFECC. Year 2004).

As mentioned previously, ceramic frit manufacture is a consolidated industrial sector and its commercial relations with the ceramic sector date back many years. The competition of other types of glazes that do not contain frits is limited owing to their inappropriate technical properties.

However, although it is a leading, strategic sector in the EU, it is necessary to take into account the threat posed by the possibility of producing ceramic frits in other countries, outside the EU, where the environmental measures, raw materials costs, energy costs and labour costs favour their competitive position in the market, compared with that of the ceramic frits produced in the EU, subject to increasingly strict regulatory requirements.

This sector has been immersed for many years in a social and entrepreneurial evolution, which, while causing the socioeconomic environment to develop, has simultaneously raised concern for our environment, in the frame of what is known globally as sustainable development, schematically depicted in Figure 7.

As frits are a key raw material for ceramic tile manufacture, the ceramic frit manufacturing sector is frequently associated with the Ceramic Tile Industry. However, within the framework of the European Union set out in the 96/61/EU Directive on Integrated Pollution Prevention and Control (IPPC), the ceramic frit manufacturing sector comes under the same head as the glass industry due to the specific characteristics of the manufacturing process and type of product.

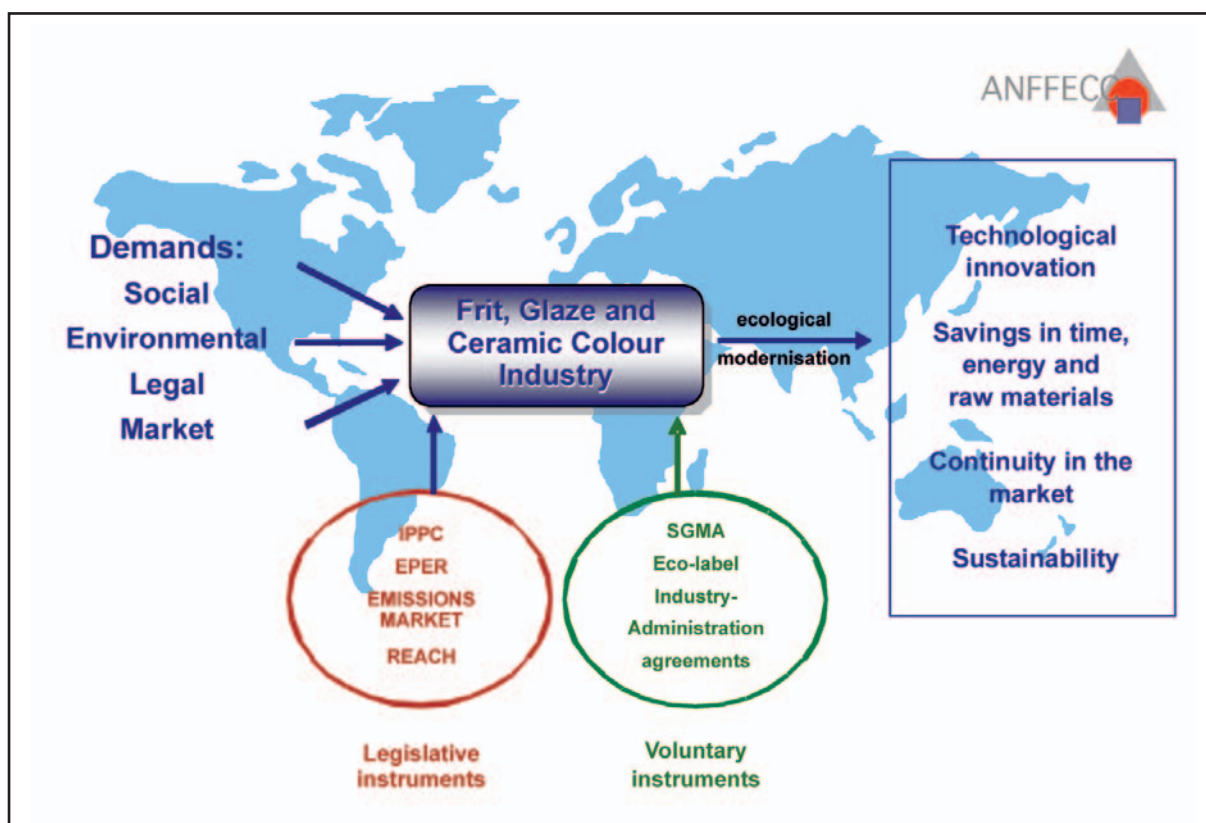


Figure 7. - Flow chart showing the interactions of social, environmental, legal and market demands applicable to the frit, glaze and ceramic colour manufacturing industry.

In environmental matters, Directive 96/61/CE on Integrated Pollution Prevention and Control (IPPC) establishes the principal regulatory framework for the sector, fixing the year 2007 as the deadline for adaptation to the new European requirements and including actions in the prevention and reduction of particle and other pollutant emissions into the atmosphere, noise reduction, quality of waste disposal, waste recycling and management, visual impact, as well as control of environmental impacts.

Since the year 1998, the frit, glaze and ceramic colour manufacturing sector has been working actively with the European Commission in the elaboration of sector reference documents within the frame of Directive 96/61/EC on Integrated Pollution Prevention and Control (IPPC), which have materialised in the Glass Bref published in the 2001 and the Bref on Inorganic Chemical Specialties to be published at the end of 2005.

These documents, disseminated by the European Commission, are part of the process of information exchange between the EU Member states, industrial sectors and other stakeholders in relation to the Best Available Techniques in integrated pollution prevention and control.

This regulatory process has continued with the transposition of Directive 96/61 into national legislation by Law 16/2002 on Integrated Pollution Prevention and Control, as well as the determination of regional and local competences, mainly for the application for Integrated Environmental Authorisation before the deadline for the existing facilities, set by the European regulations for October 2007.

In this sense, the frit, glaze and ceramic colour manufacturing sector has made great efforts in the implementation of the best existing technologies. Of note are those for instance, involving an investment of more than 45 million Euros since 2002, relative to the adaptation or implementation of treatment systems for particle emissions at fugitive sources, which occurred in the periodic self-control of the emissions originating from the ceramic frit kilns, as well as the integration of the environmental measures needed to conform to the administrative obligations of the regulation, advancing these measures by own decision, far ahead of the 2007 deadline: These have been laid down in the voluntary agreements adopted in 2003 between ANFFECC and the Department for Territory and Housing of the Generalitat Valenciana for integrated pollution prevention and control in the frit manufacturing industry.

Furthermore, under the auspices of the business association of frit, glaze and ceramic colour companies, a sector position document was prepared in the course of the year 2005, prior to the forthcoming review of the IPPC technical reference document foreseen for 2006, in which there is concern regarding the technologies and emission limits established for nitrogen oxides. Work has similarly been conducted on drafting the new reference document for the Inorganic Chemical Specialties, involving constant activity by the ANFFECC technical commission on colours.

A risk evaluation study of ceramic frits has also been conducted, coordinated by Universidad Jaume I, which is particularly of note in regard to the classification, transport and labelling of ceramic frits and their wastes, as well as for future European regulations currently being worked out, such as REACH. The study concludes from the results of the ecotoxicity and toxicity tests that ceramic frits are neither very toxic, nor toxic, nor harmful, therefore making it unnecessary for them to be assigned any risk notation, which are important conclusions for excluding frits from consideration by this European regulation.

In addition, these studies evidence the socioeconomic singularities of the frit, glaze and ceramic colour manufacturing sector, highlighting the important investment in R&D+i (innovation), particularly for performing the main lines of research and development of new products for the ceramic sector, with the dedication of extensive human resources to this activity in their own facilities. Figure 8 shows images that

have served as presentation of the sector in different documents, as well as in their dissemination events, such as from 31 May to 3 June 2005 in Brussels during the 'Green Week' of the European Commission, an international forum for the presentation of products, processes and services respectful with the environment, which meet the European directives in environmental matters.



Figure 8. Images of the presentation of the frit, glaze and ceramic colour sector.

Furthermore, as indicated in Directive 2003/87/CE of the European Union of 13 October 2003, which establishes a regime for greenhouse gas emission rights trade, in compliance with the commitments of the Kyoto Protocol, the ceramic frit industry is included in the section of Mineral Industries in Annex I, by being including in the Installations for glass manufacture, including glass fibre, with a fusion capacity exceeding 20 tons per day.

Note that the heading of the categories of activities involved in Directive 2003/87/CE is a consequence of an amendment in regard to CO₂ that this regulation entails in respect to Directive 96/61/EC on Integrated Pollution Prevention and Control (IPPC), as specifically stated in the whereas clauses of Directive 2003/87/CE.

It was for that reason, that once again, the Spanish ceramic frit manufacturing sector participated by means of ANFFECC in elaborating the National Plan of Assignments for CO₂ emission rights for the period 2005-2007, which was subsequently transmitted to the European Commission by the Ministry of the Environment. Royal Decree Law 1866/2004 of 6 September 2004 analyses the different industrial sectors affected, and sets ceramic frits in the glass sector.

It is particularly to be noted how the ceramic frit sector is described in this Royal Decree Law 1866/2004, under the head dedicated to glass: 'Part of the spectacular growth of the Spanish ceramic tile sector in recent years is due to the closeness of the frit sector which, as world leader, performing its research, development and innovation in the proximities of the manufacture of ceramic tile products, has enabled that sector

to benefit from this leadership. The sector turnover has multiplied by 4 since 1990 and more than half of production is dedicated to exports. The domestic sales go wholly to the ceramic floor and wall tile manufacturers, which is why the evolution of the frit sector is intimately bound to these and to the construction sector in general. In regard to the measures adopted by the frit sector, since 1990 all the factories have used natural gas as fuel, so that although improvements have been implemented in energy efficiency, quality of the burners and insulations, the great reduction in specific emissions took place before that year.'

However, excessive market regulations, where environmental limits are too demanding or the application of regulations with an excessive reach, in which the best available techniques or the economic impact of the administrative charges are not well evaluated, could lead to non-sustainability of the ceramic frit production sector in the present EU scenario, and a change in leadership of the sector in the global market, entailing consequences for other, related sectors, like the Ceramic Tile Industry.

This vision of the industrial reality of the frit, glaze and ceramic colour manufacturing sector is strongly influenced by the need for a balance of the social, economic and environmental aspects, which enable job creation, continuity in the market and technological innovation, pillars common with the EU Lisbon strategy in regard to competitiveness, R&D+i and employment, also taking into account the environmental demands defined within a sustainability frame. The EU summit held in Lisbon in 2000 established ambitious objectives in order to turn Europe into 'the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic development with more and better jobs and improved social cohesion'.

4. CHALLENGES OF SUSTAINABILITY AND CORPORATE SOCIAL RESPONSIBILITY OF THE FRIT, GLAZE AND CERAMIC COLOUR SECTOR IN THE INTERNATIONAL CONTEXT

As remarked in previous points, environmental requirements represent an essential parameter at present for assessing the sustainability of a production sector in the European Union, a production sector which must also integrate in its socioeconomic context.

In our case, the main environmental aspect associated with the production of ceramic frits is that it is an energy-intensive, high-temperature process. This entails emissions of combustion products and the oxidation of atmospheric nitrogen due to the high temperature.

The emissions also contain particles stemming from the volatilisation and ensuing condensation of volatile materials. Technical solutions are theoretically possible for all these emissions, but each technique entails very high environmental and economic implications, which must be evaluated to determine their feasibility in the present socioeconomic context.

In this sense, one of the basic aspects for addressing the adaptation of all the installations within the frame of Directive 96/61/CE on Integrated Pollution Prevention and Control has been appropriate knowledge of the environmental performance of the manufacturing installations, by means of the periodic self-control of the emitted

pollutants and their optimisation, with the resulting informative transparency with the competent Authority, such as, for example in the participation in the European Pollutant Emissions Register (EPER).

As far as particle emission from fugitive sources are concerned, the reduction in particle emissions originating from the handling (transport, loading and unloading) and storage of dusty raw materials have been a primary objective of the frit companies, with a view to preventing these annoyances in the work place. For this, closed installations are used, with exhaust and dust extraction from all the charging installations, and enclosure and dust exhaust from all transport systems.

With regard to the measures adopted for channelled sources (frit fusion kiln stacks), the commitment was adopted of adapting these to particle emission values in accordance with those established by Directive 96/61/CE for October 2007, with an overall adaptation percentage of 65% of the sources by 1 January 2006 and 100% of the existing sources by 1 January 2007, with sufficient time for the issuance of the Integrated Environmental Authorisations for all the frit and ceramic glaze installations. In this respect, it may be said that compliance with this commitment has been amply achieved by ANFFECC member companies, since practically all the facilities will have treatment filters operating well before the deadline.

In addition, the frit, glaze and ceramic colour companies engaged, through ANFFECC, to work in research, development and implementation of the best available techniques in order to achieve the desirable objective of minimising particle emissions for all the types of channelled emission sources.

In the same way, a very important challenge for the sustainability of the sector is considered to be the optimisation of the emission limit values of other pollutants in the ceramic frit fusion step, such as nitrogen oxides, owing to the intrinsic characteristics of the manufacturing process, using the best available techniques, both environmentally and economically.

With the best present techniques, it is considered that the frit manufacturing sector will need to make a great effort in order to reach the nitrogen oxide emission values according to the reference values established in the voluntary agreement between ANFFECC and the Department for Territory and Housing of Generalitat Valenciana, as well as to reach lower emission values through research and technological innovation in this respect, in which it is considered that many best practices have already been adopted, such as the upgrading of the frit fusion kilns, the introduction of variations in the design of the fusion kiln, modification of the combustion parameters or optimisation in the use of some raw materials in the formulations of ceramic frits.

With regard to sulphur oxides, the ceramic frit sector uses natural gas in its manufacturing process, which is why there are no environmental issues relating to such emissions, as already set out in the reference document published by the European Commission.

On the other hand, for the values of other pollutant emissions into the atmosphere, such as chlorides, fluorides, metals and their compounds, the commitment was undertaken to adopt the limit values required by Directive 96/61/EC on Integrated Pollution Prevention and Control (IPPC), also featuring an overall adaptation percentage of 65% of the sources by 1 January 2006 and of 100% of the existing sources by 1

January 2007, thus well ahead of the European demands for all of these, and in addition engaging voluntarily to keep the amount of frit produced with a high lead content from exceeding 10% by weight of total company production.

For all these emission values, the measurements will be made under normal operation conditions of the installations, with sampling gas temperatures that shall in no case exceed 300°C, to avoid problems of vitrification in the sampling probes. The measured concentrations will always be referred to standard pressure and temperature conditions (101.3 KPa, 273 K) on a dry basis and for an O₂ content of 15%.

In view of all of this, and due to the great endeavours made by the frit, glaze and ceramic colour manufacturing sector to adapt its installations to the environmental requirements defined by the European Union through the reference documents published to date, it is considered of great importance that these achievements should be understood as great challenges for the sector. It is important to take into account the sustainability criteria when it comes to reviewing these reference documents, scheduled for 2006, with a view to consolidating the frit, glaze and ceramic colour industry in the present socioeconomic scenario within the EU; it is also of great importance in regard to the repercussions for establishing production in the present geographic areas, and keeping the sector's leadership in the global market, with the consequent synergy with the ceramic floor and wall tile manufacturing industry.



Figure 9. Glassy appearance of ceramic frits after the fusion and fritting stages.

In addition, a further challenge for the frit, glaze and ceramic colour manufacturing sector is related to the characterisation of its products in the market, closely tied to the regulations on transport, labelling and commercialisation of products made in the EU, based on their glassy state characteristic, as shown in Figure 9.

In this sense, the European Frit and Ceramic Glaze Industry, by agreement on a common position between the Spanish National Association of Frit, Glaze and Ceramic Colour Manufacturers (ANFFECC) and the Italian Association of Ceramic Glaze and Metallic Oxide Manufacturers (CERAMICOLOR), and endorsed by other producers located in different EU Member States are concerned about the impact on this sector of the legislative proposal on chemical products by the European Commission (REACH),

as Spain and Italy are the main manufacturers of these products, with a turnover of more than 1000 million euro per annum, representing more than 5,000 direct jobs, and having a direct impact on the ceramic tile industry, also fundamentally located in Spain and Italy.

The origin of this proposal is the review of the policy on chemical products requested by the Council of the EU Environment Ministers and the 'White Book of the Commission on the Strategy for the Future Policy the Future Policy on Dangerous Substances and Preparations'. The ultimate target of this White Book is the chemical industry and the goods produced by this sector ('chemical products'). This document contains various recommendations for a safer future use; for the maintenance of the competitiveness of the chemical industry; for transparency in the information, etc. In fact, the regulation proposal already mentions the chemical industry in the first whereas clause of the text.

However, the present proposal text is extraordinarily wide in its definition of the concept of 'substances and preparations', to the extent that it could even be understood that the requirements requested of the producers of chemical substances, or the importers of preparations that contain these substances, also affect other sectors that have nothing to do with the REACH objectives (ceramic frit industry, glass industry, cement producers, ceramic industry, etc.).

Logically, ceramic frits, their preparations and their wastes should not enter REACH or be affected by the scope of its application in any way, fundamentally for the reasons set out previously, in relation to their physico-chemical characteristics and the already adopted environmental regulations.

The frit, glaze and ceramic colour sector share, with other industrial sectors, such as that of lime, cement, ceramics, glass, and with other EU Member States, the opinion that the present draft of the proposal is out of all proportion in regard to the objectives indicated in the White Book, and that this text will impose an enormous bureaucratic burden on the industry, which will mean immediate growth of direct and indirect costs, and loss of competitiveness for the EU, with a great economic impact, especially for the SMEs.

In this sense, through ANFFECC, the frit, glaze and ceramic colour manufacturing sector has promoted the performance of a risk evaluation study for ceramic frits, with a view to characterising its products environmentally and to considering their implications in the different transport, labelling and classification regulations for ceramic frits.

The study is the result of extensive analysis work conducted for over five years, according to the work procedure described in Figure 10, in order to demonstrate that ceramic frits are a vitreous inert substance and, consequently, not toxic.

In order to carry out these analyses, the Technical Commission of ANFFECC made a preliminary classification of six different groups of frits, based on their composition, which were representative of all commercialised frits, including the most complex frits. The study demonstrates that not even in these last frits did any type of toxicity develop.

The tests, conducted at the request of ANFFECC and coordinated by the Organic and Inorganic Chemical Department of Universitat Jaume I (UJI), have been carried

out at accredited analysis laboratories, specialising in these types of studies. The Central Service of Scientific Instrumentation of the UJI was charged with the study and characterisation of the materials. The RCC Laboratory in Switzerland was charged with the inhalation and ecotoxicity studies, while the Centre for Applied Research and Development SAL (CIDASAL), located in Barcelona, performed the oral and skin toxicological tests.

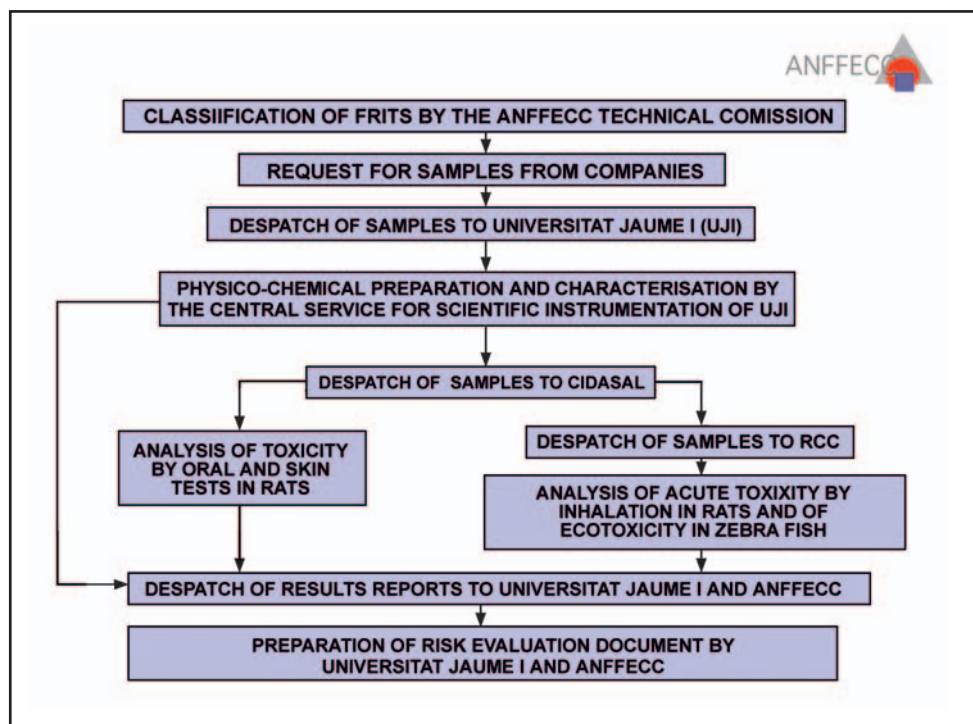


Figure 10. Work procedure followed in the elaboration of the risk evaluation study of ceramic frits, under the scientific coordination of Universitat Jaume I of Castellón.

The results of the toxicity and ecotoxicity analyses confirmed that ceramic frits present no type of risk for human health or for the environment. It was established that ceramic frits are neither very toxic, nor toxic, nor harmful, which is why they should not be assigned any risk notation. These conclusions confirm that ceramic frits are a glassy product with physical and chemical characteristics that have nothing to do with the raw materials that form them.

These excellent results, after due examination by the competent authorities, should exclude ceramic frits from the obligation to be assigned any risk notation, safety data cards with a risk annotation or special treatment when it comes to their transport, commercialisation, handling and use; nor should their wastes to be classified as dangerous. In addition, they will be able to contribute to the criteria of the Community ecolabel and will be unaffected by the Agreement concerning the International Carriage of Dangerous Substances by Road (ADR), Directive 67/548/CEE on classification, packing and labelling of dangerous substances, and the Regulation of the Council in relation to the Export and Import of dangerous chemical substances.

This study also forms the basis for requesting exclusion from the obligation to register ceramic frits in the future REACH regulation of chemical substances, as a substance is involved of a vitreous nature, and the study allows optimising the

economic impact of the environmental measures for ceramic frit producers, as they are not subject to certain formalities which are demonstrated to be unnecessary.

5. CONCLUSIONS

The sustainability strategy of the frit, glaze and ceramic colour manufacturing sector is framed within the EU Lisbon strategy of competitiveness, creation of employment and innovation. These actions are based on integration of the information and fostering of the dissemination of the sector's specific situation in the issues of greatest present and future relevance at regional, national and international level.

The challenge of sustainability for the frit, glaze and ceramic colour manufacturing sector includes social and environmental commitment and responsibility, taking into account the continuity in the market in our socioeconomic context and the management of the existing information with the competent Authorities, as well as the international dissemination of the results in R&D+i in regard to the environment, energy efficiency and product classification and characterisation, so that the various efforts made in technological, environmental and socioeconomic matters by the frit, glaze and ceramic colour sector, in the frame of sustainable development and compliance with the environmental objectives set, are taken into consideration.

The main challenges are based on the development and management of actions related to the analysis of the specific social, economic and environmental singularities, by means of scientific, technical and legal study of each scenario, specially in regard to the review of the reference document that establishes the Best Available Techniques (BAT) for the emissions of nitrogen oxides, energy efficiency, R&D+i, product classification and communication strategies of the sector.

Therefore, it is fundamental to integrate all the environmental information of the sector, to disseminate the technological improvements that have been adopted and to set out the own specifications of the production processes for the correct determination of the BAT and the instruments for controlling atmospheric emissions, especially in regard to nitrogen oxides, energy efficiency, R&D+i, product classification and communication, in view of the new scenarios to be addressed at European Union level, with direct consequences in national regulations and in autonomic and local competences.

In view of the foregoing, the attainment of the objectives established by the present challenges is structured by coordination of all the stakeholders needed to obtain the integration and dissemination of the sector's socioeconomic and environmental variables in the work forums required to assure the sector's competitiveness in the global market, opting for innovation and the creation of employment. Figure 11 outlines the participation process in work forums at local, regional, national and international levels of the frit, glaze and ceramic colour manufacturing sector in the EU context.

Analogously, similar information integration and management processes are followed in regard to energy efficiency, to prepare and adapt the installations to the demands of Directive 2003/87/CE on the assignment of greenhouse gas emission rights, as well as for the correct classification of the products in the market, by preparation of actions in innovation and research, in addition to communication and dissemination of the results, which favour the correct classification of processes and

products in existing regulations, such as Directive 96/61/CE on Integrated Pollution Prevention and Control (IPPC), and potential new regulations, such as the one relative to the registration, evaluation, authorisation and restriction of chemical substances and preparations (REACH).

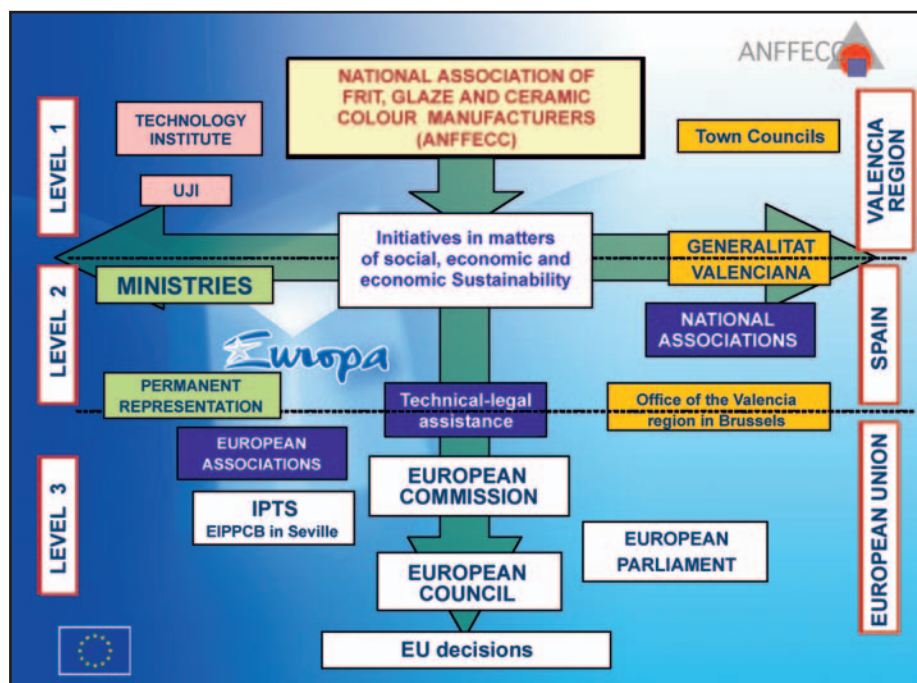


Figure 11. Scheme of the participation process in work forums at local, regional, national and international levels in the EU context.

Where it is found that the implementation of proposed techniques such the BAT prevents the viability of the sector, these must be considered unfeasible because of the social and economic impact they entail, and an evaluation must then be carried out from the point of view of 'implementation speed', determining the most appropriate environmental values, even though this may pose an important environmental challenge to the sector.

For this, the evaluation of the social, economic and environmental variable in the frit, glaze and ceramic colour sector is essential, in view of the critical aspects to be taken into account, such as: 'Industry structure', 'market structure' and 'sector strength'.

REFERENCES

- [1] SECRETARÍA GENERAL TÉCNICA. MINISTERIO DE FOMENTO. ADR 2005. Acuerdo europeo Sobre Transporte Internacional de Mercancías Peligrosas por Carretera. (2005)
- [2] NACIONES UNIDAS. Sistema Globalmente Armonizado de Clasificación y Etiquetado de productos químicos (SGA). 2003 (ISBN 92-1-316006-2)
- [3] INSTITUTE FOR HEALTH AND CONSUMER PROTECTION. European Chemicals Bureau. Technical Guidance Document on Risk Assessment. <http://ecb.jrc.it/>
- [4] Digital publication of the Bureau de Prospecciones Tecnológicas (Sevilla): <http://eippcb.jrc.es/>
- [5] Digital publication on the Registro Europeo de Emisiones (EPER): www.eper-es.com

- [6] M. IRÚN. "Inversiones y gastos medioambientales de las empresas. La situación actual del mercado medioambiental en el entorno socioeconómico de la provincia de Castellón" V Conferencias sobre Medio Ambiente. Medio Ambiente y empresa. Comité Económico y Social (ISBN 84-931569-3-0), 2002
- [7] E.CORDONCILLO, P.ESCRIBANO, J.B. CARDACASTELLÓ. "Esmaltes y pigmentos cerámicos". Enciclopedia Cerámica. Tomo I., capítulo "Situación medioambiental de la fabricación de fritas y esmaltes cerámicos" 2001, Faenza Editrice Iberica s.l (ISBN 84-87683-19-3)
- [8] EUROPEAN COMMISSION & INSTITUTE FOR PROSPECTIVE TECHNOLOGICAL STUDIES (IPITS). Integrated Pollution Prevention and Control. Documento de referencia de las mejores técnicas disponibles en la industria de producción de vidrio. Sevilla, 2001
- [9] M.IRÚN, I.DÍAZ-NEBOT, J. BAKALI, J.B. CARDACASTELLÓ "Diseño, Control y Caracterización de Emisiones en la Fabricación de Fritas. Adecuación de la planificación Integral de Producción a las Variables Medioambientales" VI Congreso Internacional QUALICER, 2000.
- [10] IRÚN, M.; NEBOT-DÍAZ, I.; CARDACASTELLÓ, J.B.: "Situación medioambiental de la fabricación de fritas y esmaltes cerámicos. Contribución de las emisiones atmosféricas a la calidad del aire ambiente". V Congreso Nacional de Medio Ambiente. Comunicaciones técnicas. 2000.
- [11] REBOLLO, J.M.; CORMA, P.: "Modelo para la determinación de aspectos e impactos medioambientales en el sector cerámico", Ediceram, 1, pp. 19-37, (2000).
- [12] SALAZAR, J. L.: "La ecoeficiencia, una condición necesaria para el desarrollo sostenible en Europa", 2º Congreso de Química i Medi ambient. La producció més neta en el marc de l'ecoeficiència industrial", Barcelona, 2000.
- [13] GENERALITAT VALENCIANA. "El Cluster azulejero en Castellón. Iniciativa de refuerzo de la competitividad", 1999.
- [14] MONFORT, E.; CELADES, I.: "Cuestiones sobre medio ambiente para un técnico cerámico", Instituto de Tecnología Cerámica, Castellón, 1999.
- [15] VICKERY, W.; MORENO, A.; MONFORT, E.: "Influencia de las Materias Primas Borácicas en las Emisiones de los hornos de Fusión de Fritas". Qualicer'98. V Congreso Mundial de la Calidad del Azulejo y del Pavimento Cerámico, Castellón, 1998.
- [16] SEOÁNEZ CALVO, M. Medio Ambiente y Desarrollo: Manual de Gestión de los Recursos en función del Medio Ambiente. Ediciones Mundi-Prensa. Madrid, 1998.
- [17] NACIONES UNIDAS. Recomendaciones Relativas al Transporte de Mercancías Peligrosas. Reglamentación Modelo. 10ª Edición (1997).
- [18] SEOÁNEZ M.; ANGULO, I.: "El Medio Ambiente en la Opinión Pública", Ed. Mundi Prensa, Madrid, 1997.
- [19] ZILLGITT, M. Materiales para la Decoración Cerámica. Recomendaciones para su correcta manipulación. ANFFECC, CERAMICOLOR, EPSOM, VdMi. (1995).
- [20] NACIONES UNIDAS. Recomendaciones Relativas al Transporte de Mercancías Peligrosas. Manual de Pruebas y Criterios. 2ª Edición (1995).
- [21] CARDACASTELLÓ, J., RINCÓN, J.M., ALARCÓN, J. Nuevos Productos y Tecnologías de Esmaltes y Pigmentos Cerámicos. Ed. Faenza Editrice Ibérica S.L. Castellón (1992)
- [22] ITC, AICE. Tratamiento de Emisiones Gaseosas, Efluentes Líquidos y Residuos Sólidos de la Industria Cerámica. Castellón 1992.
- [23] BLASCO, A.; ESCARDINO, A.; BUSANI, G.: "Tratamiento de emisiones gaseosas, efluentes líquidos y residuos sólidos de la industria cerámica". Asociación de Investigación de las Industrias Cerámicas: Instituto de Tecnología Cerámica, Castellón, 1992.
- [24] COMISIÓN MUNDIAL DEL MEDIO AMBIENTE Y DEL DESARROLLO: "Nuestro futuro común", Ed. Alianza, 1992.
- [25] LÓPEZ MATEO, L., RAVAGLIOLI, A., ENRIQUE NAVARRO, J.E. Contaminación por plomo y problemática de los esmaltes plumbíferos. Boletín de la Sociedad Española de Cerámica y Vidrio. Volumen 16, nº2 (1977) pp73-81.
- [26] F. SINGER Y S. SINGER. Cerámica Industrial, vol.1. Enciclopedia de la Química Industrial, Ed. Urmo, Bilbao (1971), tomo 9, pp. 436-437.

Legal frame for classification of substances and their wastes

- Proposal of Regulation of the European Parliament and of the Council relative to the registration, evaluation, authorisation and restriction of chemical substances and preparations (REACH), by which the European Agency of Chemical Substances and Preparations was created and Directive 1999/48/CE and the Regulation (CE) on Persistent Organic Pollutants were amended.
- Proposal of Directive of the European Parliament and of the Council by which Directive 67/548/CEE of the Council is modified to adapt it to the 'REACH Regulation'.
- Regulation 180/2000, relative to an eco-label award system.
- Royal Decree 363/1995, of 10 March, by which the Regulation is approved on the notification of new substances and classification, packaging and labelling of dangerous substances.
- Commission Regulation (EC) No 1488/94 on Risk Assessment for existing substances.
- Order of 13 October 1989, by which the methods for characterising toxic and dangerous wastes are determined. (BOE no. 270, of 10 November 1989).
- Directive 67/548/CEE on labelling and packing of chemical substances.
- Law 10/2000, of 12 December, Wastes of the Valencia Region.
- Directive 1999/31/CE of the Council, of 26 April 1999, relative to waste disposal.
- Law 10/1998, of 21 April, on Wastes (BOE no. 96m of 22 April 1998)
- Royal Decree 833/1998, of 20 July, by which the regulation for the execution of Law 20/1986 Basic law on toxic and dangerous wastes (BOE no. 182, of 30 July 1988) is approved. (Amended by R.D. 952/1997)
- Integral Wastes Plan for the Valencia Region (PIR), approved by the Valencian Government by Decree 317/1997, of 24 December, of the Generalitat Valenciana Council and published in the DOGV on 13 January 1998.
- National Plan of Dangerous Wastes (1995-2000). (Text approved by the Council of Ministers on 17 February 1995).
- Law 11/1997 of 24 April 1997 on packagings of waste packagings.
- Directive 94/62/CE of 20 December 1994 on packagings of waste packagings.

Legal frame for pollution prevention and control

- Directive 2003/87/CE of 13 October 2003 on the regime for greenhouse gas emission rights trade.
- Decision 2000/479/CE, on the realisation of a European Pollutant Emissions Register (EPER).
- Directive 96/61/CE of the Council of 24 September 1996, on the integrated pollution prevention and control. (IPPC).
- Royal Decree 1613/1985, of 1 August, by which Decree 833/1975 is partly amended, of 6 February, and new standards of air quality are established regarding pollution by sulphur dioxide and particles. (BOE of 12.09.85).
- Decree 833/1975, of 6 February, by which Law 38/1972 is developed, of 22 December, on the protection of the atmospheric environment. (BOE of 22.04.75).
- Law 38/1972, of 22 December, on the protection of the atmospheric environment. (BOE of 26.12.72).

Legal frame for discharges

- Royal Decree 419/1993 of 26 March, by which the sanctions established in article 109 of Law 29/1985, of 2 August, on Waters, are updated, and certain articles of the Regulation of the Hydraulic Public Dominion, approved by Royal Decree 849/1986, of 11 April are amended. (BOE of 14.04.93).
- Royal Decree 1315/1992 of 30 October, by which the Regulation of the Hydraulic Public Dominion is partly amended, which develops the titles Preliminary, I, IV, V, VI and VII of Law 29/1985, 3 August, on Waters, approved by Royal Decree 849/1986, of 11 April. (BOE of 01.12.92).
- Royal Decree 849/1986, of 11 April 1986, by which the Regulation of the Hydraulic Public Dominion is approved, which develops the titles Preliminary, I, IV, V, VI and VII of Law 29/1985, of 3 August, on Waters. (BOE of 30.04.86).
- Law on Waters 29/1985, of 2 August 1985 (BOE of 08.08.85)