ECODESIGN CERTIFICATION ACCORDING TO ISO 14006. APPLICATION TO THE DIE FOR CERAMIC TILE PRODUCTION

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ABSTRACT

Product-oriented environmental certification has focused in recent years mainly on Eco-labels and Environmental Declarations in the frame of a family of ISO 1402X standards (Type I and III labelling, respectively).

However, standard ISO 14006 has recently been approved, which allows organisations that adopt a management system to identify, control and continuously improve the environmental aspects of their products and/or services to be differentiated. This facilitates the process of transferring information to clients on products that embody environmental improvements through product design.

This paper describes the main features of standard ISO 14006 and analyses its application to a company from the metal-mechanics sector, specialising in the design, manufacture, and repair and maintenance of dies for the production of ceramic tiles. The following stages were therefore followed: [1)]analysis of the die manufacturing and repair process; [2)]annual compilation of data on production, raw materials consumption,

energy consumption, waste generation, etc.; 3)assignment of data to the functional unit defined for each process (drilling, mechanical machining, rectification, cutting, winding, wire electro-erosion, welding, punch vulcanisation, etc.) by measuring electric power consumption directly at the machines; 4)modelling of the life cycle inventory of each raw material, ancillary materials, unit processes and transport operations; 5)application of life cycle assessment (LCA) methodologies to several dies, with a view to obtaining environmental indicators that allow the significant environmental aspects to be identified; and 6)proposal of objectives for environmental improvement.

This has led to the generation of the required documentation (procedure and records) for Ecodesign certification according to standard ISO 14006 and its application to a specific die model. It must be taken into account that the environmentally more respectful obtainment of ceramic tiles entails the search for more respectful materials, techniques and production processes. However, it should be borne in mind that the product's entire life cycle must be analysed, including the equipment and tools used. The application of ecodesign to a ceramic die will allow dies to be obtained with a lower impact in their use and in their manufacturing stages, thus contributing to this extent, to the environmental improvement of the ceramic tiles made with these dies.

1. INTRODUCTION

Organisations, increasingly aware of the importance of managing the environmental impacts of their activities and products, recognise the need to include environmental performance in their product design.

Ecodesign may be understood as a process integrated within the product design and development process, aimed at reducing environmental impacts and continuously improving product environmental performance throughout the product life cycle, from the raw materials extraction to the end of the product working life.

Standard UNE 150301 on performing ecodesign in a systematic way in an organisation was published in 2003. After five years of experience in its implementation in various Spanish organisations, AENOR (the Spanish Association for Standardisation and Certification) promoted the creation of an international standard that could be integrated in current quality and environmental management systems, ISO 9000 and ISO 14001, respectively. Finally, in 2011, standard ISO 14006 (2011) was published: "Environmental management system. Guidelines for incorporating ecodesign".

This paper presents the project on the application of standard ISO 14006 to a company from the metal-mechanics sector, specialising in the design, manufacture, and repair and maintenance of dies for the production of ceramic tiles.

2. ISO 14006

Standard ISO 14006 (2011) "Environmental management system. Guidelines for incorporating ecodesign", provides the basic guidelines to help organisations establish, document, implement, maintain and continuously improve their management of ecode-

sign as part of an environmental management system. These guidelines are applicable to any organisation, independently of its size or activity, and affect the environmental aspects relating to the product that the organisation can control or influence.

This standard is related to and follows the structure of other product design, environment, and quality management standards, as shown in Figures 1 and 2.

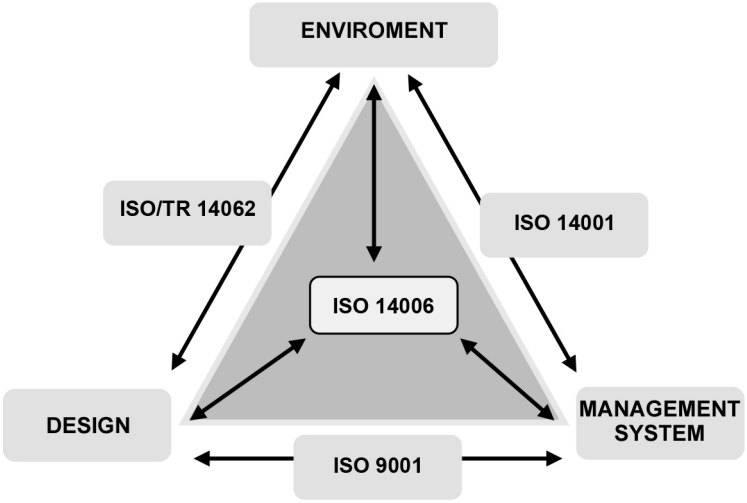

Figure 1. Interrelationship of ISO 14006 with other standards.

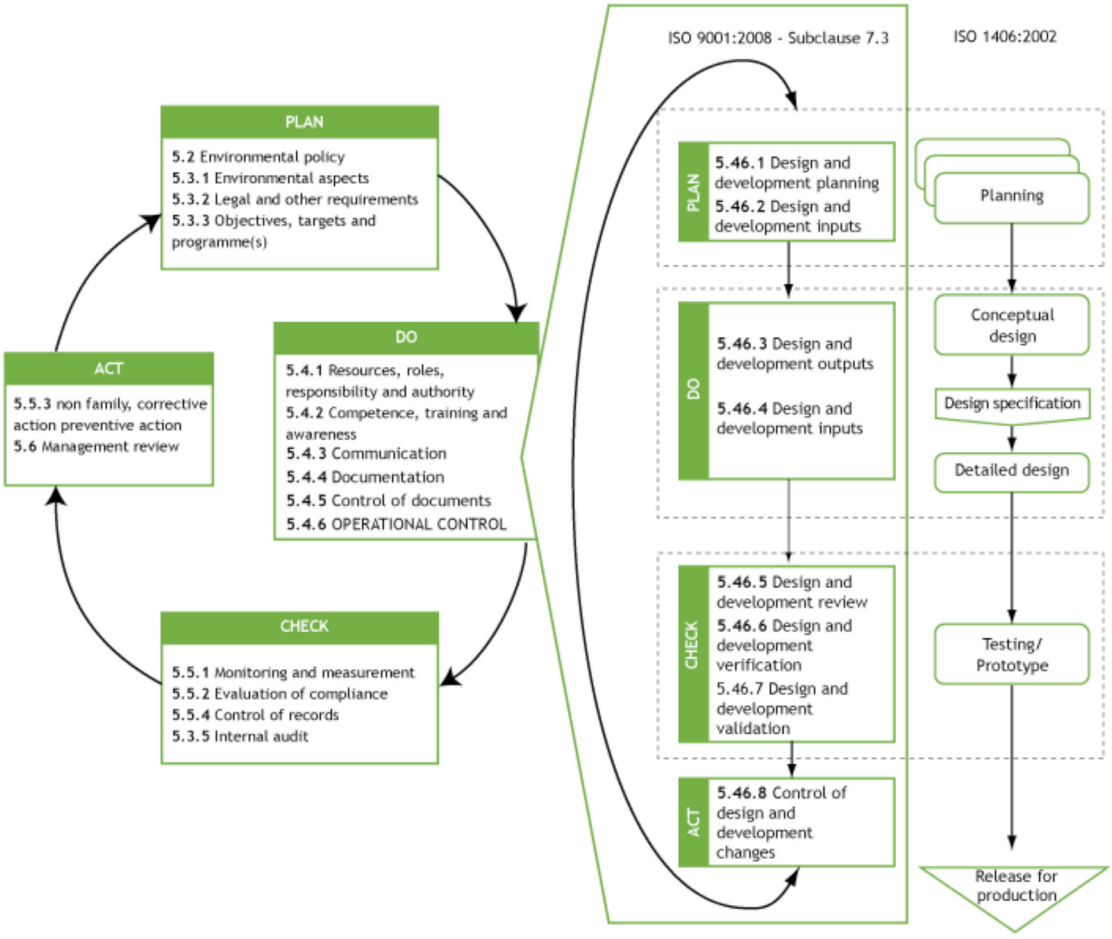

Figure 2. Interrelationship of ISO 14006 content with ISO 14001, ISO 9001 and ISO/TR 14062.

Once the certification process has been passed, if the implemented system conforms to the requirements of standard ISO 14006, the organisation can obtain the ecodesign management certificate, the annex in which the certified organisation's eco-designed products are detailed, and the right to use the logotype that certifies this (Figure 3).

Figure 3. AENOR logotype of Ecodesign certification, according to ISO 14006.

3. METHODOLOGY

The application of standard ISO 14006 (2011) to a company that manufactures dies for the production of ceramic tiles has entailed performance of the following two main groups of activities:

- Development of a method based on the Life Cycle Assessment (LCA) methodology according to ISO 14044-44 (2006), to identify the significant environmental aspects and to quantify the environmental improvement of the products, adapted to the specific case of dies for ceramic tile production, and

- Generation of the required documentation (procedure and records) for ecodesign certification according to standard ISO 14006, and its application to a particular die model.

3.1. APPLICATION OF THE LCA METHODOLOGY

In order to have a method for quantifying the environmental impacts of the dies involved, the Life Cycle Assessment methodology was applied to identify the significant environmental aspects of the product, and to have a systematics that would allow the environmental improvement deriving from the incorporation of changes in its design to be quantified.

This was done according to the steps shown in Figure 4, which include the application of the LCA methodology according to ISO 14040-44 (2006).

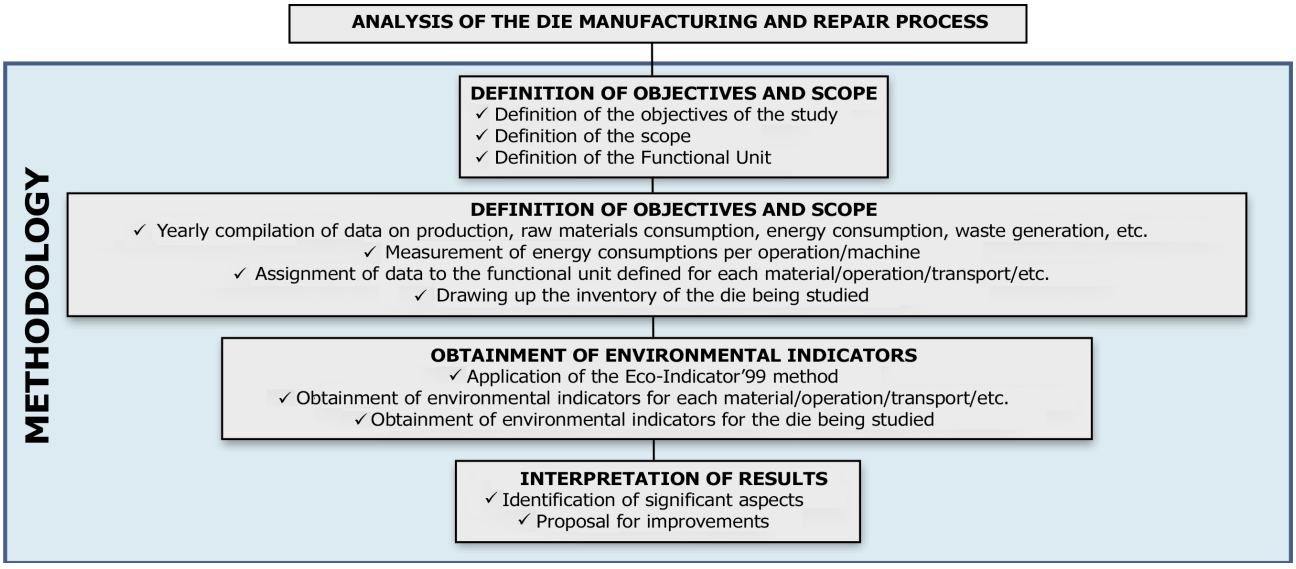

Figure 4. Stages for drawing up the method to identify significant aspects and to quantify the environmental improvement obtained by applying changes in design for that purpose.

Analysis of the die manufacturing and repair process

In this stage, the current situation of die production in the company was analysed in order to achieve a good understanding of the process and the working procedures. Based on the specialised literature (Galindo, 2008), direct observation of the die manufacturing process, and interviews with company personnel, a comprehensive vision was obtained of the die life cycle in the manufacturing stage.

The die use and maintenance stage was more difficult to study because this did not just depend on the die manufacturing company, but also on the companies making the ceramic products. Some of these companies were therefore visited and, after selecting a small group of their dies, the corresponding die monitoring reports were reviewed.

When this stage had been completed, sufficient knowledge of the die life cycle had been obtained, and the unit processes into they could be divided, in addition to the inputs and outputs that of each these required in terms of materials, operations, energy consumptions, etc., had been identified.

Definition of objectives and scope

This study targeted two basic objectives:

- to determine the environmental impact of all the raw materials, ancillary materials, operations, waste, etc., which form part of the life cycle of a die, whose functional units (FU) are shown in Table 1 and

- to determine the environmental profile of the penetrating die with 2 outputs sized 30x90cm, whose functional unit is to perform 1.000.000 pressing cycles.

The scope of the study is shown in the dotted box in Figure 5.

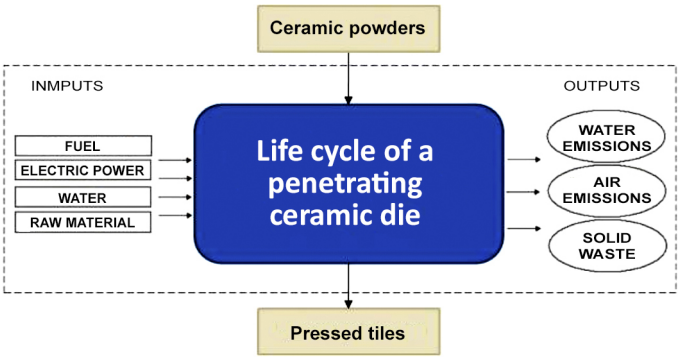

Figura 5. Scope of the study.

Preparation of a characteristic life cycle inventory for the sector

In order to be able to perform a LCA study, it is necessary to have an inventory database that includes all the raw materials, ancillary materials, operations, energy resources, etc., which form part of the life cycle of a die.

To do this, the following actions were taken:

- yearly compilation of data on production, raw materials consumption, energy consumption, waste generation, etc.
- measurement of energy consumptions per operation/machine.
- assignment of data to the functional unit defined for each operation/machine
- obtainment of the environmental indicator for each raw material, ancillary material, operation, etc., shown in Table 1.

Raw/ancillary materials (UF = 1 kg)	Standard components (UF = 1 ud)	Operations (UF = 1 hora)	Transportation (UF = 1 tkm)
Non-alloyed steel	Screws and bolts	Milling	Boat
Pre-tempered steel	Bellows	Drilling	40 t lorry
Alloyed steel cold work	Electric resistances	Drawing and marking	16 t lorry
5xxx aluminium	Washers	Threading	Van
6xxx aluminium	Covers and caps	Rectifying	…
Copper	Tubes	Cutting	
Brass	Insulation	Heating	
St-37 sheet	Housings	Oil loading	
Sheet rubber	Pins	Wire electro-erosion	
Liquid rubber	Joints	Welding	
…	Connections	Tempering	
	…	…	

Table 1. Materials, operations, means of transport, included in the inventory.

In order to model each material/operation/means of transport/etc., the Ecoinvent (2008) inventory database was used as a reference, adapting it to the case of an application in Spain by adjusting the electric power, distances, transportation, etc., "mix". Each of these inventories was modelled in the SimaPro® 7.1 (2010) software.

Once the database had been modelled, the inventory of the die being studied was drawn up, dividing the die life cycle into the following stages: manufacture, transportation and distribution, use, reuse and maintenance, and recycling and removal.

Figure 6 shows a screenshot of the SimaPro® software, displaying the model of the die use, reuse and maintenance stage.

Nombre: USO.PEN_1: P1+C1+P2 | Imagen: macer | Comentario: VIDA ÚTIL: 1.000.000 DE CICLOS DE PRENSADO

Estado: Terminado

Materiales/Ensamblajes	Cantidad	Unidad	Distribución	Comentario
C1.Conjunto Cuchillas	0,67	p	Indefinido	VIDA ÚTIL: 600.000 ciclos de prensado. Necesario el inicial más 0,67 juegos más (400.000)
RC1.Conjunto Cuchillas	6,33	p	Indefinido	Este tipo de cuchillas suelen repararse 4 veces antes de desecharse, cada 150.000 ciclos. Nº reparaciones: 4 + 2,33 = 6,33
P1.Punzón Inf. 30x90 SIN Compensación	6,66	p	Indefinido	VIDA ÚTIL: 300.000 ciclos de prensado. Necesario el inicial más 3,33 pares más (700.000)
RP1.Punzón Inf. 30x90 SIN Compensación	7,32	p	Indefinido	Este tipo de punzones suele repararse 1 vez antes de desecharse, cada 150.000 ciclos. Nº reparaciones: 2 x (1 + 1 + 1 + 0,66) = 7,32
P2.Punzón Sup. 30x90 CON Compensación MGV1	6	p	Indefinido	VIDA ÚTIL: 250.000 ciclos de prensado. Necesario el inicial más 3 pares más (1.000.000)
RP2.Punzón Sup. 30x90 CON Compensación MGV1	8	p	Indefinido	Este tipo de punzón suele repararse 1 vez antes de desecharse, cada 125.000 ciclos. Nº reparaciones: 2 x (1 + 1 + 1 + 1) = 8
RMarco con CuchillasTradicionales, con Calefacción	1	p	Indefinido	Se estima una reparación de este tipo.
RPlaca Salvabanco	1	p	Indefinido	Se estima una reparación de este tipo.
RPlaca Expulsora	1	p	Indefinido	Se estima una reparación de este tipo.
(Insertar línea aquí)				

Procesos	Cantidad	Unidad	Distribución	Comentario
Furgoneta: Transport, van <3.5t/RER U	32,41	tkm	Indefinido	Para el transporte I/V de las cuchillas a reparar. Macer --> Empresa Azulejera (20 km) 6,33 x 2 x (0,128) t x 20 km = 32,41 tkm
Camión pequeño_tara 4495: Transport, lorry 3.5-7.5t, EURO4/RER U	57,39	tkm	Indefinido	Para el transporte I/V de los punzones inferiores a reparar. Macer --> Empresa Azulejera (20 km) 7,32 x 2 x (0,196) t x 20 km = 57,39 tkm
Camión pequeño_tara 4495: Transport, lorry 3.5-7.5t, EURO4/RER U	88,34	tkm	Indefinido	Para el transporte I/V de los punzones MGV1 a reparar. Macer --> Empresa Azulejera (20 km) 8 x 2 x (0,276) t x 20 km = 88,34 tkm
Camión pequeño_tara 4495: Transport, lorry 3.5-7.5t, EURO4/RER U	128,4	tkm	Indefinido	Para el transporte I/V de las grandes placas a reparar. Macer --> Empresa Azulejera (20 km) 2 x (1,471+0,834+0,905) t x 20 km = 128,4 tkm
(Insertar línea aquí)				

Figure 6. Screenshot of the SimaPro® software, with the model of the die use stage.

The environmental impact of the die was distributed over its life cycle stages: acquisition of raw materials (production of raw material and/or materials, in addition to transportation to the company); production of the die; distribution; and removal/end-of-life. An indicator is obtained for each of these items.

Assessment of the environmental impact

The environmental impact assessment stage of the life cycle serves to assess the importance of the environmental impacts using the results obtained in the inventory stage. Although different impact assessment methods are available, in this study an endpoint method like Eco-Indicator'99 was chosen, which allows the environmental load of the system analysed to be express in a single indicator (Pt). The structure of this environmental impact assessment is shown in Figure 7.

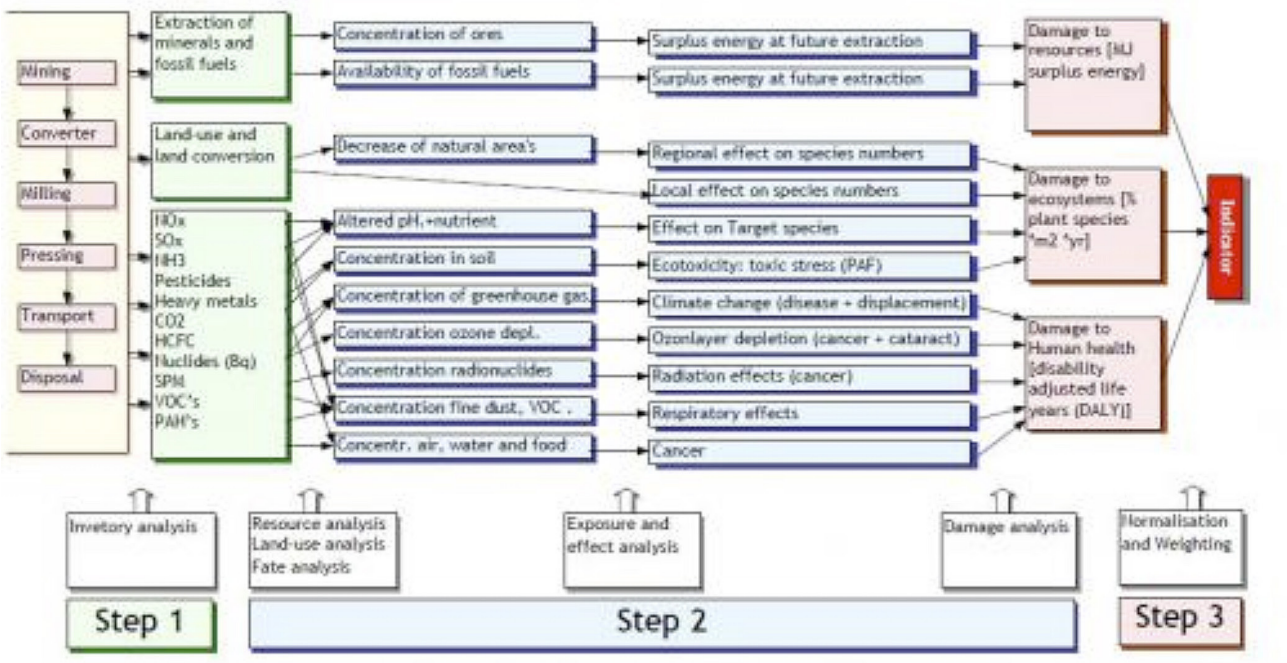

Figure 7. Model of the Eco-Indicator 99 impact assessment method (Goedkoop & Spriensma, 1999).

Figure 8 shows the environmental impact of a die of the penetrating type distributed over its life cycle stages..

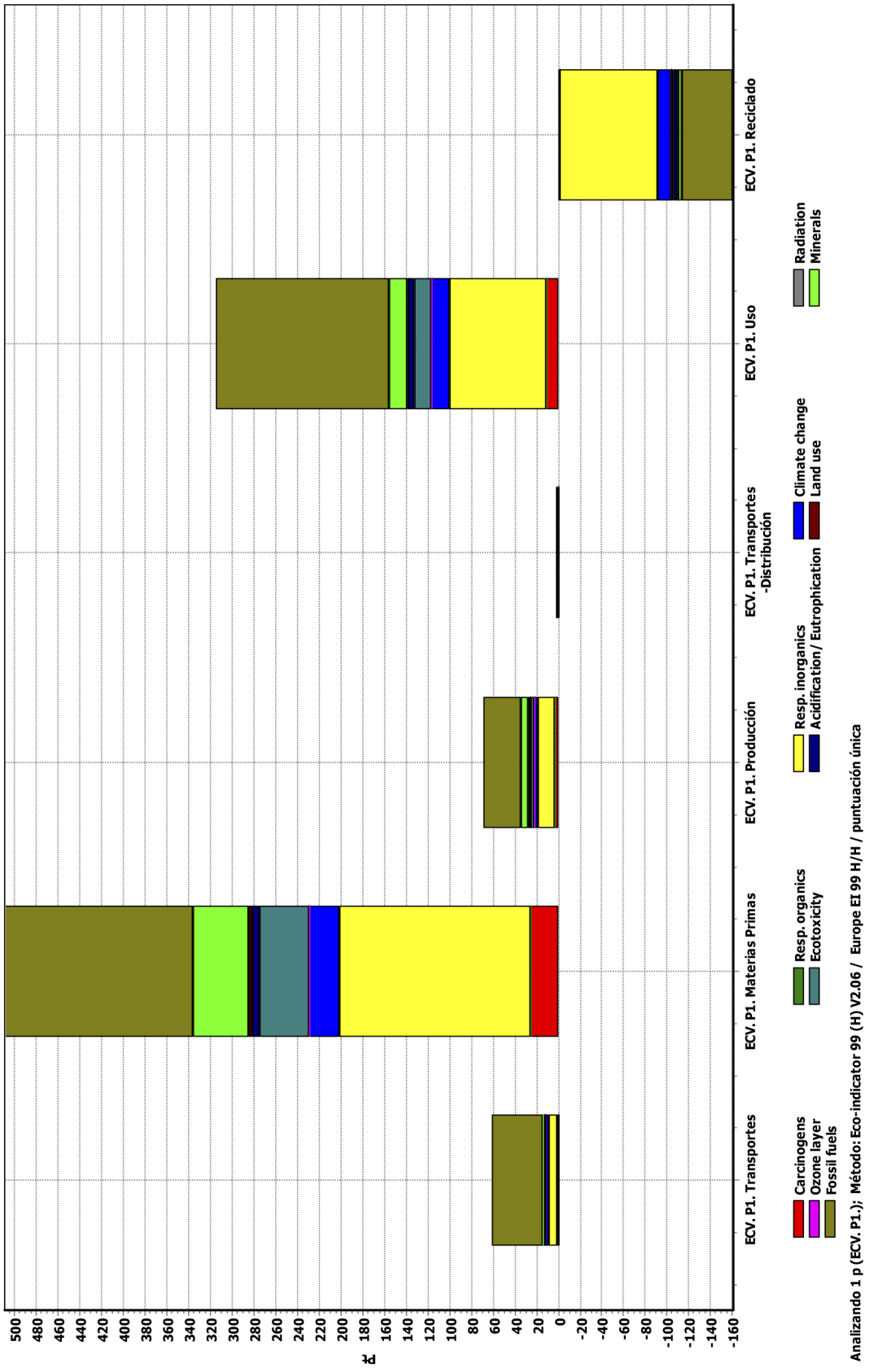

Figure 8. Breakdown of the environmental impact of a die distributed over the life cycle stages.

3.2. DOCUMENTATION REQUIRED BY ISO 14006

Once the nature and requirements for ecodesign certification according to standard ISO 14006 had been determined, the documentation that needed to be prepared by the Company for submission to an accredited body to obtain the relevant certification was prepared:

- "Procedure for identification and assessment of the environmental aspects of the product", which includes an annex with the "Tables of eco-indicators for assessing the environmental impact of the dies during their life cycle", as shown in Figure 9.

- "Record of identification and assessment of environmental aspects for the product family: penetrating dies", as shown in Figure 10.

ELEMENT	FUNCTIONAL UNIT	INDICATOR EI99 (mPt)
Non-alloyed Steel	1 kg	96,4
Pre-tempered steel	1 kg	117,0
Steel for cold work	1 kg	316,0
5xxx aluminium	1 kg	565,0
6xxx aluminium	1 kg	556,0
Copper	1 kg	2160,0
Brass	1 kg	1830,0
St-37 sheet	1 m^2	1510,0
Machined St-37 sheet	1 m^2	4580,0
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Milling steel large pieces_307: Metal-milling machine F01	1 hr	279,0
Milling steel large pieces 134: Metal-milling machine F02	1 hr	287,0
Milling steel large pieces 155: Metal-milling machine F03	1 hr	382,0
Milling punches BEVEL AND EMPTY 288: Metal-milling machine F05	1 hr	145,0
Milling punches MEASUREMENT 288: Metal-milling machine F05	1 hr	120,0
Milling steel small pieces Metal-milling machine F05	1 hr	173,0
Rectifting punches 308: Rectifier R01	1 hr	805,0
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Small lorry Tare 4495: Transport, lorry 3.5-7.5t, EURO4/RER U	1 tkm	46,0
Van: Transport, van <3.5t/RER U	1 tkm	136,0
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Steel and iron recycling	1 kg	-78,1
Aluminium recycling	1 kg	-769,0
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Allen Screw 5x10 12.9	1 p	0,3
Allen Screw 16x120 12.9	1 p	20,3
Hexagonal Screw 16x55	1 p	10,4
Expansion Screw 6x20	1 p	0,4

Figure 9. Extract of the Table of Eco-indicators.

COMPONENTE	REFERENCIA	Nº COMPO-NENTES	MATERIA PRIMA				PROCESO ASOCIADO					TRANSPORTE DE MATERIA PRIMA					VALORACIÓN TOTAL (Pt)	SIGNIFI-CANCIA
			MATERIAL	PESO	EI'99 (mPt)	PESO x EI'99 (Pt)	TIPO	MAGNITUD	UNIDAD	EI'99 (mPt)	MAGNITUD x EI'99 (Pt)	RECORRIDO	KM	MEDIO	EI'99 (mPt)	PESO/1000 x KM x EI'99 (Pt)		
Bloqueto inferior magnético	xxxx/yyyy1	2	Acero no aleado	526,0	96,4	50,7	Fresado_252	8,00	hr	212,0	1,696	Italia → Valencia	1712	Camión PMA 40000	7,0	6,32	87,83	S
							Taladrado_150	4,00	hr	72,8	0,291							
							Taladrado_152	5,50	hr	251,0	1,381							
							Transporte A	2,20	km	46,0	0,101	Valencia → Almazora (MACER)	70	Camión tara 4495	46,0	1,69		
							Bobinado	6,56	kg	3.790,0	24,862							
							Rectificado_308	0,75	hr	1.030,0	0,773							
Marco con cuchillas tradicionales y sistema de calefacción interior	xxxx/yyyy2	1	Acero no aleado	1.471,0	96,4	141,8	Fresado_307	7,25	hr	279,0	2,023	Italia → Valencia	1712	Camión PMA 40000	7,0	17,68	173,18	S
							Fresado_155	15,00	hr	382,0	5,730							
							Taladrado_152	7,00	hr	251,0	1,757							
							Taladrado_150	0,50	hr	72,8	0,036							
							Roscado_153	2,00	hr	9,8	0,020	Valencia → Almazora (MACER)	70	Camión tara 10700	19,9	2,05		
							Montaje	3,00	hr	6,3	0,019							
							Rectificado_308	2,00	hr	1.030,0	2,060							
Conjunto cuchillas	xxxx/yyyy3	1	Acero aleado para trabajo en frío	128,6	316,0	40,6	Corte_235	1,00	hr	66,6	0,067	Austria → Valencia	2148	Camión PMA 40000	7,0	1,94	72,97	
							Fresado_138	1,75	hr	282,0	0,494							
							Fresado_A	7,00	hr	151,0	1,057							
							Taladrado_249	0,60	hr	40,6	0,024							
							Transporte B	164,00	km	136,0	22,304							
							Templado_Ext.	128,58	kg	15,7	2,019							
							Rectificado_Ext.	4,20	hr	333,0	1,399	Valencia → Almazora (MACER)	67	Camión tara 4495	46,0	0,40		
							Rectificado_140	4,20	hr	333,0	1,399							
							Rectificado_154	4,00	hr	126,0	0,504							
							Fresado_A	1,25	hr	151,0	0,189							
							Rectificado_168	0,70	hr	155,0	0,109							
							Rectificado_154	3,50	hr	126,0	0,441							
Sistema especial calefacción interior marco	xxxx/yyyy4	1	-	-	-	-	Fresado_155	0,75	hr	382,0	0,287	-	-	-	-	-	1,64	
							Fresado_304	3,00	hr	283,0	0,849							
							Taladrado_152I	2,00	hr	251,0	0,502							
Placa expulsora	xxxx/yyyy5	1	Acero no aleado	834,0	96,4	80,4	Fresado_307	3,00	hr	279,0	0,837	Italia → Valencia	1712	Camión PMA 40000	7,0	10,02	95,40	S
							Taladrado_307	7,00	hr	241,0	1,687							
							Taladrado_152	1,00	hr	251,0	0,251							
							Roscado_153	1,50	hr	9,8	0,015	Valencia → Almazora (MACER)	70	Camión tara 10700	19,9	1,16		
							Rectificado_308	1,00	hr	1.030,0	1,030							
Conjunto perfiles aluminio placa salvabanco	xxxx/yyyy6	1	Aluminio 5xxx	18,6	565,0	10,5	Corte_157	0,30	hr	29,8	0,009	Italia → Valencia	1712	Camión PMA 40000	7,0	0,22	11,91	
							Fresado_156	6,50	hr	161,0	1,047							
							Roscado_153	0,40	hr	9,8	0,004	Valencia → Almazora (MACER)	70	Camión tara 4495	46,0	0,06		
							Taladrado_151	1,75	hr	37,5	0,066							

Figure 10. Extract of the Record of assessment of significant environmental aspects for the product family: penetrating dies.

4. CONCLUSIONS

In this study, a life cycle assessment was performed of a die for the production of ceramic tiles, which has allowed the necessary information to be obtained to write up the procedures and record models required for the incorporation of ecodesign into an environmental management system according to ISO 14006 (2011).

The following overall conclusions of the project may be noted:

- A great amount of knowledge was obtained on the life cycle of dies for the production of ceramic tiles.
- The components of the die, materials, processes, etc., were identified that have the greatest environmental impact.
- A robust life cycle inventory was drawn up that can be used by the company as a tool to assess the environmental impact of its products.
- The documentation required for certification according to standard ISO 14006 (2011) was prepared.

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