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A VERIFIED ENVIRONMENTAL DECLARATION

AENOR

Styrene-butadiene-styrene (SBS) polymer

Environmental Product Declaration

EN ISO 14025:2010
EN 15804:2012+A2:2019
EN 15804:2012+A2:2019/AC:2021

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Dynasol Group

Sustainability
Dynasol Group

DYNASOL ELASTÓMEROS, S.A.U.

The holder of this Declaration is responsible for its contents and for keeping the documentation that supports the data and statements included during the validity period.

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AENOR is a founding member of the ECO Platform, the European Association of Environmental Product Declaration verification programmes.

The European Standard EN 15804:2012+A2:2020 serves as PCR for this EPD.

Independent verification of the declaration and data, according to the EN ISO 14025:2010 standard

☐ Internal ☒External

Verification body

AENOR

Product certification body accredited by ENAC with accreditation No. 1/C-PR468

1. General information.

1.1. The company.

Dynasol Group is a company dedicated to the manufacture of synthetic rubber and rubber chemicals. It is one of the leading companies in this sector, with a strong international presence with production plants in Europe, America and Asia, which allows it to serve customers around the world.

Dynasol Group is the result of a strategic alliance between Repsol (Spain) and Grupo KUO (Mexico). This structure has allowed it to access synergies in terms of technology, production capacity and market access.

Dynasol Group has several production sites globally, including **Dynasol Elastómeros, SAU.**

1.2. Scope of the Declaration.

This Environmental Product Declaration includes environmental information on a group of products manufactured by a single manufacturer, Dynasol Elastómeros, SAU, in a geographical and technological environment of Spain during the year 2023.

The results shown present the environmental performance of the average Styrene-Butadiene-Styrene (SBS) polymer produced at the Dynasol Elastómeros SAU plant in Gajano, Cantabria (Spain), weighted by production. The scope of this Environmental Product Declaration (hereinafter EPD) is “from cradle to gate”.

1.3. Life cycle and conformity.

This EPD has been developed and verified in accordance with UNE-EN ISO 14025:2010 and UNE-EN 15804:2012+A2:2020/AC:2021 “Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products”.

TABLA 1. PRODUCT CATEGORY RULES	
Descriptive title	Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
Record code and version	UNE-EN 15804:2012+A2:2020/AC:2021
Issue date	2021-10-27
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This Environmental Declaration includes the following life cycle stages:

Tabla 2. System boundaries. Information modules considered

Product stage	A1	Raw material supply	X
	A2	Transport to the factory	X
	A3	Manufacturing	X
Const.	A4	Transport to the site	MNE
	A5	Installation / construction	MNE
Use stage	B1	Use	MNE
	B2	Maintenance	MNE
	B3	Repairs	MNE
	B4	Replacement	MNE
	B5	Restoration	MNE
	B6	Operational energy use	MNE
	B7	Operational water use	MNE
End of life	C1	De-construction / demolition	MNE
	C2	Transport	MNE
	C3	Waste treatment	MNE
	C4	Disposal	MNE
	D	Re-usage, recovery and/or recycling potential	MNE

X = Module included in the LCA; NR = Irrelevant module; MNE = Module not assessed

This EPD may not be comparable with those developed in other Programmes or based on different reference documents.

Similarly, EPDs may not be comparable if the source of the data is different (for example, databases), not all relevant information modules are included or they are not based on the same scenarios.

The comparison of construction products must be made on the same function, applying the same functional unit and at the building level (or architectural or engineering work), that is, including the behaviour of the product throughout its life cycle, as well as the specifications of section 6.7.2 of the UNE-EN ISO 14025 Standard.

2. The product

2.1. Product identification

Styrene-butadiene-styrene, often abbreviated SBS, is a synthetic thermoplastic elastomer obtained by polymerizing a mixture of styrene and butadiene. It is a block copolymer of styrene and butadiene that improves the mechanical properties of the materials with which it is combined, providing both elasticity and structural stability. It is commonly used in applications such as adhesives, compounds, sealants, waterproofing, and pavements, as well as in the modification of asphalt to improve its durability.

The CPC code for the product is 34800 “Synthetic rubber and factice derived from oils, and mixtures thereof with natural rubber and similar natural gums, in primary forms or in plates, sheets or strip”.

SBS belongs to the class of thermoplastic elastomers that combine the elastic properties of rubber at room temperature with the ease of processing of thermoplastics. Unlike cross-linked rubbers, such as vulcanized rubbers, SBS does not require this process, which simplifies its manufacture and reuse. SBS exhibits a softening point in the range of 160-200°C (320-400°F), allowing it to be processed in a variety of industrial applications.

SBS offers an excellent coefficient of surface friction, low permanent deformation, high tensile strength, optimal low temperature performance, and good processability. In addition, its structure makes it ideal for applications such as asphalt modification, adhesives and sealants.

2.2. Intended use of the product.

Applications:

- Roads
- Waterproofing
- Plastic modification
- Composites
- Adhesives
- Composites (without BHT / TNPP)

2.3. Product composition.

Below is the average composition of the grades included in this declaration.

Table 3. Product composition

Substance/Component	Content	Unit
Butadiene	67	%
Styrene	28	%
Additives	5	%

None of the components of the final product are included in the Candidate List of Substances of Very High Concern (SVHC) for authorisation or subject to any other regulation.

2.4. Product features.

The following table refers to the general technical characteristics of the styrene-butadiene-styrene (SBS) polymers included in this EPD.

Table 4. Product features

SBS Calprene										
Grade	Styrene, %	Structure	Brookfield Viscosity, cP @25% wt, 25°C	Toluene Solution Viscosity, cSt (@ 5,23%, 25°C)	Melt Flow Index, (g/10min)	Applications				
C-401	20	Radial	9700	18		●	●		●	●
C-411	30		18500	26		●	●			●
C-412	31.5		23100	28			●	●		
C-413	31.5		23100	28			●	●		
C-419	30		11100	20		●	●	●		●
C-480	34		15000	21			●	●		
C-711	30		18500	26		●			●	●
C-719	30		11100	20					●	●
C-500	30	Linear	1100		5(3)	●			●	●
C-501	31		5000	13		●	●	●		●
C-540H	40		600		5.5(3)	●			●	●
C-580	31.5		1950	9.5			●	●		
C-700	30		1100		5(3)	●			●	●
C-701	31		5000	13		●			●	●
C-710	30		1700	8		●	●		●	●
C-718	25		1500		6(3)				●	●
C-7318	32		700	7	5(3)	●				
C-743	43		360		19(3)	●			●	●

Adhesives Paving Membranes Polymer Modification & Compounding Footwear

(1): at 20% wt and 25°C & (2): at 10% wt and 25°C & (3): 190°C / 5 kg

3. Information about LCA

3.1. Life Cycle Assessment

The study "SBS LIFE CYCLE ASSESSMENT - Santander Plant v1" on which this EPD is based has been prepared from data provided directly by Dynasol Group for its SBS polymer products, manufactured in 2023 in a single production centre, located in Gajano, Santander (Spain).

The life cycle assessment (LCA) on which this declaration is based has been carried out following the ISO 14040, ISO 14044 and UNE-EN 15804:2012+A2:2020/AC:2021 standards.

The LCA was carried out with the support of SimaPro 9.6.0.1 software and Ecoinvent database version 3.10 (2023).

3.2. Declared Unit.

The Declared Unit considered is "1 tonne of SBS produced at the Santander plant".

3.3. Reference service life (RSL)

Not applicable.

3.4. Allocation criteria

More than 95% of all mass and energy inputs and outputs of the system have been included in this study.

The following data are excluded:
- Non-regulated atmospheric polluting emissions, from sources channelled by combustion.
- The production of industrial machinery and equipment.

3.5. Representativeness, quality and selection of data.

Primary data have been provided directly by Dynasol Group and correspond to a production centre owned by it. Secondary data have been used in the Ecoinvent 3.10 databases and modelled with Simapro version 9.6.0.1. All data correspond to a geographical scenario of Spain 2023. The results presented are representative of SBS polymers, expressed as a production-weighted average.

3.6. Other calculation rules and hypotheses.

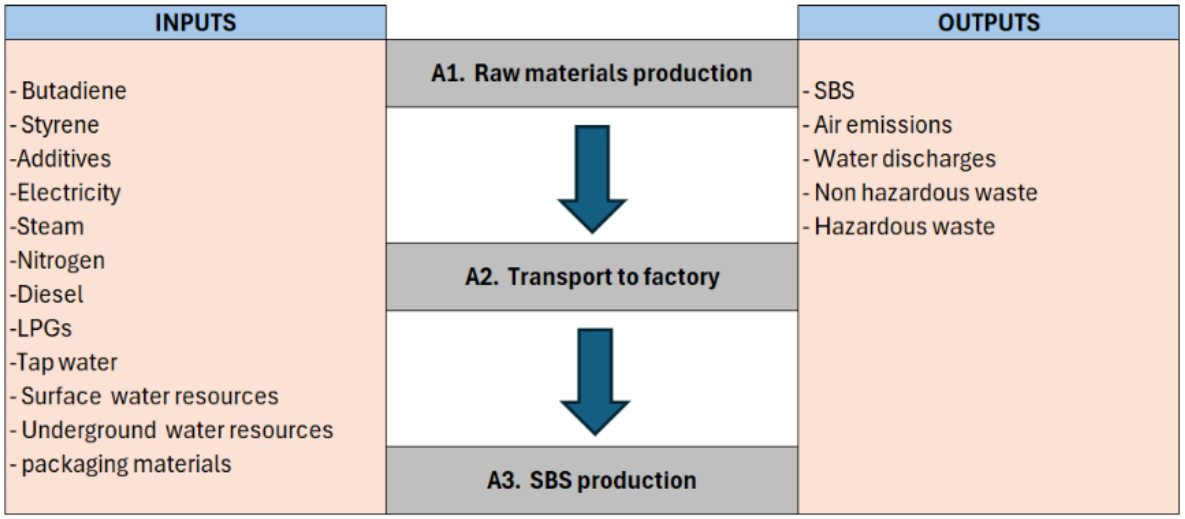
The declared product is an average product that includes various grades of SBS. The impacts generated by the grade with the lowest impact and the grade with the highest impact (calculated taking into account the quantity of butadiene, styrene present in the composition of each grade, their electricity and steam consumption) have been studied.

To check the representativeness of the average results, the coefficient of variation was calculated by dividing the standard deviation by the value of the arithmetic mean of the results of these products, obtaining a coefficient of variation of 4.21% for the results of the Global Warming impact category (GWP-total – kg CO2 eq).

No universal criteria have been established to indicate that a coefficient value is "low" or "high". However, in practice, values of less than 30% or 40% are low, between 30/40% and 80% are moderate, and values over 120% or 140% indicate a very high dispersion rate.

4. SYSTEM BOUNDARIES, SCENARIOS AND ADDITIONAL TECHNICAL INFORMATION.

As this is a “cradle-to-gate” study, the life cycle modules A1 (production of raw materials), A2 (transport to factory) and A3 (production of the product) have been included.



4.1. Pre-manufacturing processes (upstream).

Raw materials (A1 y A2).

SBS polymers are thermoplastic elastomers that combine the properties of rubber and plastics. Their main raw materials are styrene, which provides a rigid structure that improves the polymer's ability to be moulded and stabilised, and butadiene, which is responsible for the elastic properties of the product. Other auxiliaries (additives and modifiers) are added to these raw materials.

At this stage the following have been taken into account:

- Extraction and processing of raw materials.

- Generation of electricity and steam from primary energy resources, including their extraction, refining and transportation.

The electricity mix has been calculated for the year 2023 according to data from the mix of the marketing companies without GOs published by the CNMC: 2.66E-01 KgCO2 eq/kwh.

The transport of all raw and ancillary materials from the production sites (suppliers) to the production facilities has been considered, distinguishing in each of them the mode of transport used: ship, truck or railway.

4.2. Product manufacturing.

Module A3 - Description of the manufacturing processes.

The production process of SBS (Styrene-Butadiene-Styrene) polymer is carried out by anionic block polymerization, which allows the formation of a thermoplastic elastomer with specific elasticity and resistance properties. Each of the key stages of the process is described below:

Preparation of Monomers

Styrene and Butadiene: The main monomers, styrene and butadiene, are obtained from petrochemical sources. They are stored in liquid form under controlled conditions of pressure and temperature.

To ensure the quality of the polymer, the monomers are purified, removing impurities and compounds that could interfere with polymerization.

Anionic Block Polymerization

SBS polymerization occurs by an anionic polymerization mechanism, where styrene and butadiene blocks are polymerized in a controlled manner.

The molecular weight and distribution of the polymer chains are controlled by adjusting the amount of initiator and monomer, allowing the properties of SBS to be tailored to the final application (such as adhesives, asphalts or molded products).

Use of Solvents

During polymerization, the monomers and initiator are dissolved in a solvent that facilitates homogeneous mixing of the reactants and control of the reaction temperature. The solvent acts as a medium in which the reaction can be carried out in a controlled manner.

Completion of the Reaction

Termination: Once polymerization is complete, the reaction is stopped by the addition of terminating agents (such as alcohols or water) to neutralize reactive sites on the polymer chains.

The solvent used during the reaction is removed by distillation or evaporation. This leaves the SBS polymer in a solid form.

Mixing and Additivation

In some cases, additives such as antioxidants and thermal stabilizers are incorporated into the SBS polymer to improve its stability and properties during processing and end use.

Extraction and Drying

The crude polymer is withdrawn from the reactor and subjected to extraction to remove solvent residues and unreacted monomers. The material is then dried to obtain a pure polymer.

Extrusion

Once the polymer has been mixed and additives have been added, it is processed through extruders, where it is heated and shaped to obtain pellets, which is the most common commercial form for sale or further processing.

Cooling and Packaging

SBS pellets are cooled and dried to prevent agglomeration and facilitate handling. They are then packaged and ready for distribution.

5. Declaration of environmental parameters of the LCA and ICV.

The estimated impact results are relative and do not indicate the final value of the impact categories, nor do they refer to threshold values, safety margins or risks.

Table 5. Potential environmental impacts. 1t SBS.

Parameter	Units	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	**kg CO2 eq**	3,90E+03	3,23E+01	9,27E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
GWP-fossil	**kg CO2 eq**	3,89E+03	3,23E+01	9,29E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
GWP-biogenic	**kg CO2 eq**	8,22E+00	-1,99E-03	-2,04E-01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
GWP-luluc	**kg CO2 eq**	1,34E+00	1,37E-02	5,60E-02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
ODP	**kg CFC11 eq**	1,49E-04	5,41E-07	1,91E-06	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
AP	**mol H+ eq**	1,12E+01	4,23E-01	2,26E-01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
EP-freshwater	**kg P eq**	5,77E-02	2,61E-04	1,92E-03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
EP-marine	**kg N eq**	2,07E+00	1,37E-01	5,03E-02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
EP-terrestrial	**mol N eq**	2,28E+01	1,51E+00	5,69E-01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
POCP	**Kg NMVOC eq**	1,69E+01	4,37E-01	2,00E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
ADP-minerals& metals [2]	**kg Sb eq**	2,31E-02	4,59E-05	4,85E-04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
ADP-fossil [2]	**MJ**	1,04E+05	4,11E+02	1,25E+03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
WDP [2]	**m^3 depriv.**	5,60E+02	1,62E+00	6,11E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE

GWP - total: Global warming potential; **GWP - fossil**: Global warming potential of fossil fuels; **GWP - biogenic**: Global warming potential - biogenic; **GWP - luluc**: Global warming potential associated with the use and change of use of soils; **ODP**: Ozone depletion potential; **AP**: Cumulative excess acidification potential; **EP-freshwater**: Eutrophication potential, nutrient fraction reaching the final fresh water component; **EP-marine**: Eutrophication potential, nutrient fraction reaching the final seawater component; **EP-terrestrial**: Eutrophication potential, cumulative excess; **POCP**: Tropospheric ozone formation potential; **ADP-minerals&metals**: Abiotic resource depletion potential for non-fossil resources; **APD-fossil**: Abiotic resource depletion potential for fossil resources; **WDP**: Water depletion potential (user), weighted water deprivation consumption. **NR**: Not relevant

Table 6. Additional potential environmental impacts. 1t SBS.

Parameter	Units	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	**Incidence of diseases**	8,76E-05	2,12E-06	1,81E-06	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
IRP [1]	**kBq U235 eq**	1,17E+02	1,70E-01	1,75E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
ETP-fw [2]	**CTUe**	1,08E+04	1,16E+02	1,48E+03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
HTP-c [2]	**CTUh**	1,35E-05	2,20E-07	3,28E-07	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
HTP-nc [2]	**CTUh**	2,45E-05	1,22E-07	1,73E-06	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
SQP [2]	**-**	8,08E+03	1,29E+02	1,32E+03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE

PM: Potential incidence of diseases due to particulate matter **(PM) emissions**; IRP: Efficiency of exposure of human potential related to U235; **ETP-fw**: Comparative potential of toxic units in ecosystems - fresh water; **HTP-c**: Comparative potential of toxic units in ecosystems - carcinogenic effects; **HTP-nc**: Comparative potential of toxic units in ecosystems - non-carcinogenic effects; **SQP**: Soil quality potential index; **NR**: Not relevant

Warning 1: This impact category deals primarily with the possible impacts of low doses of ionising radiation on human health throughout the nuclear fuel cycle. The effects of possible nuclear accidents or occupational exposure due to the elimination of radioactive waste in underground installations are not taken into account. Similarly, this parameter is not used to measure the ionising radiation potential of soils due to the presence of radon or other construction materials.

Warning 2: The results of this environmental impact indicator must be used with caution, since they have high uncertainty levels and the experience with this parameter is limited.

Table 7. Use of resources. 1t SBS.

Parameter	Units	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	**MJ**	2,09E+03	7,30E+00	2,73E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PERM	**MJ**	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PERT	**MJ**	2,09E+03	7,30E+00	2,73E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PENRE	**MJ**	6,44E+04	4,37E+02	1,34E+03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PENRM	**MJ**	4,74E+04	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PENRT	**MJ**	1,12E+05	4,37E+02	1,34E+03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
SM	**kg**	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
RSF	**MJ**	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
NRSF	**MJ**	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
FW	**m^3**	1,57E+01	5,37E-02	1,43E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE

PERE = Use of renewable primary energy excluding renewable primary energy resources as raw materials; **PERM** = Use of renewable primary energy as raw materials; **PERT** = Total use of renewable primary energy;**PENRE** = Use of non-renewable primary energy, excluding nonrenewable primary energy resources as raw materials; **PERNRM** = Use of non-renewable primary energy as raw materials; **PERNRT** = Total use of non-renewable primary energy resources; SM = Use of secondary materials; **RSF** = Use of renewable secondary fuels; **NRSF** = Use of non-renewable secondary fuels; **FW** = Net use of freshwater resources; **NR**: Not relevant

Table 8. Output flows and waste categories**. 1t SBS.**

Parameter	Units	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	**kg**	1,51E+00	2,51E-03	2,13E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
NHWD	**kg**	2,66E+02	4,42E+00	1,74E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
RWD	**kg**	8,07E-02	1,13E-04	1,40E-03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
CRU	**kg**	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
MFR	**kg**	0,00E+00	0,00E+00	4,60E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
MER	**kg**	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
EE	**MJ**	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE

HWD = Hazardous waste disposed; **NHWD** = Non-hazardous waste disposed; **RWD** = Radioactive waste disposed; **CRU** = Components for re-use; **MFR** = Materials for recycling; **MER** = Materials for energy recovery; **EEE**= Exported electrical energy; **EET** = Exported thermal energy; **NR**: Not relevant

6. Additional environmental information .

SBS polymers do not emit any compounds into the soil or water during their use stage thanks to their chemical stability and low solubility in water; they are not biodegradable and do not negatively affect other materials with which they come into contact in a way that could lead to environmental pollution or harm human health.

It is a product that does not leach and therefore does not pose a risk to the quality of surface or groundwater.

The product does not contain biogenic carbon, therefore the biogenic carbon content in the product is not declared.

DYNASOL SBS packaging is less than 5% of the total weight of the corresponding final product, therefore, following the indications of the reference standard, the declaration of the biogenic carbon content of the packaging is omitted.

7. REFERENCES

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