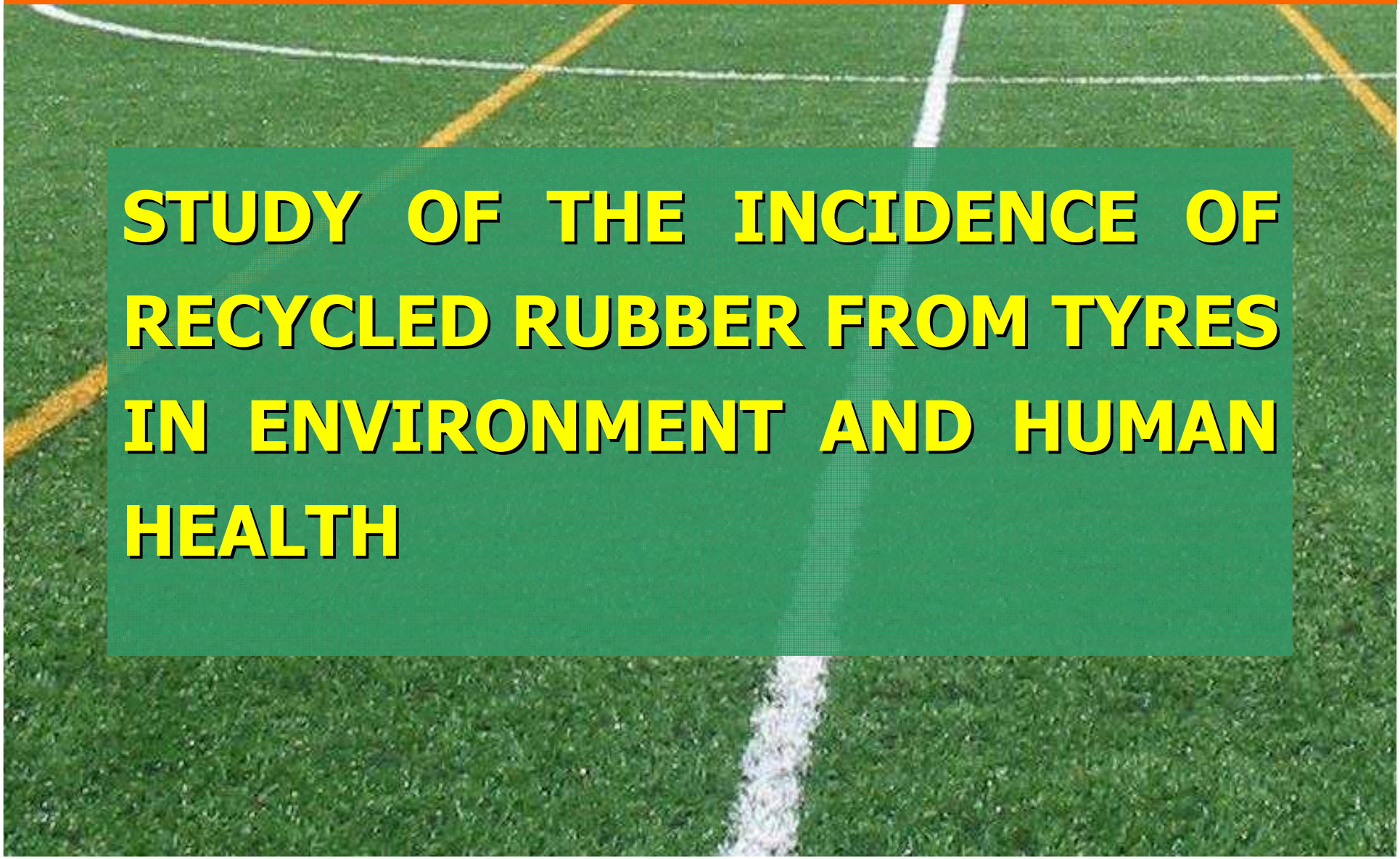

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STUDY OF THE INCIDENCE OF RECYCLED RUBBER FROM TYRES IN ENVIRONMENT AND HUMAN HEALTH

Indice

Antecedents

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- In the last months, toxicity of recycled tyres has affected to artificial turf pavements because they are used like infill in this kind of pitches. In this sense, the IBV together with recycling companies and a company of installation of sports surfaces, have developed a project which allows knowing on the one hand the legislation about this product and on the other what is the real behaviour of this material.

Participants **Renecal, Alfredo Mesalles, GMN, Biosafe y Poligras**

Antecedents

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- For it, there has been selected a sample of rubber recycled by mechanical procedure in a mixture of 70 % of truck and 30 % of cars.
- Only a concrete type of rubber has been evaluated recycled because of it the results are applied to this concrete sample and to have best proved it should do the study on more types of recycled rubber

Antecedents

WHY DOES THIS PROBLEM COME UP?

- **GERMAN CONSULENCE REPPORT (INTRO):** Being alert of the risks of the content in HAP of the rubber recycled by dermal contact.

- **OPEN LETTER OF FIFA AND UEFA:** On potential risks of cancer of granulated fill for surfaces of artificial turf.

  - It presents studies that they conclude that the HAP's that contain the recycled tires, are not eliminated.
  - WHO (World Health Organization): There are no studies that relate particles of tires to problems of human health.

Study approach

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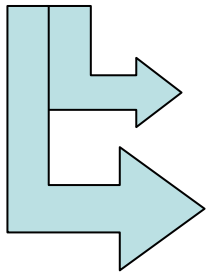
APPLUS + MEDIO AMBIENTE AFTER KNOWING:



This problematic

The recycled material composition

SUGGEST THREE STUDY STAGES:

- **STAGE I:** MATERIAL BEHAVIOUR ON HUMAN HEALTH AND ENVIRONMENT.
- **STAGE II:** LEACHING EFFECT ON SOIL.
- **STAGE III:** RECYCLED MATERIAL FFECTS ON AIR.

Study legal framework

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GENERAL CRITERIA FOLLOWED TO SELECT THE LEGISLATION TO APPLYING IN THE STUDY:

- **It is necessary to bear in mind that there does not exist legislation of direct application for the raised problem.**

- **Therefore there has been in use the legislation (first national and later European) and regulation that adapts better in each case to the raised problem.**

Study legal framework

GENERAL CRITERIA FOLLOWED TO SELECT THE LEGISLATION TO APPLYING IN THE STUDY(2):

STAGES I AND II

- **To fulfill in order the first two phases that included both the composition and the behavior of the material, it has been considered to be, on the basis of the laboratory experience, use the systematical one, analytical methodology and values limit, gathered in the wide legislative existing fan to national level, which approaches in depth both the characterization of residues and its arrangement in the environment.**

Study legal framework

GENERAL CRITERIA FOLLOWED TO SELECT THE LEGISLATION TO APPLYING IN THE STUDY(3):

STAGE III

- **To take to end the aim of this phase it has been studied the effect of the material on the atmosphere, considering both the quality of the air and the risks generated by the possible emissions of this material.**

- **Both the evaluation of the air quality and the potential risks evaluation for the human health, have been realized on the basis of national and European legislation in force or in project, as well as in normative documents published by international recognized agencies.**

LEGAL FRAMEWORK

1. **In order to evaluate the dangerousness of the material two types of tests are realized:**

   - Analysis of metallic and organic compounds capable of enduring risks for the health and the environment.
   - Tests physicist - chemist who determine the characteristics of dangerousness of the material.

2. **The analyzed parameters are gathered in:**

   - R.D. 952/1997, of June 20 by which the regulation is modified for the execution of the Law 20/1986, of May 14, basic of Toxic and Dangerous Residues, pass by means of R.D. 833/1988, of July 20.

R.D. = Real Decree in Spain

LEGAL FRAMEWORK (2)

3. The used methodology is defined in

- R.D. 363/1995, of March 10, by which the regulation is approved on notification of new substances and classification, packed and labeled of dangerous substances.

- Order on October 13, 1989 on methods of characterization of the toxic and dangerous residues.

4. The criteria used to evaluate the dangerousness of the analyzed parameters are gathered for:

- Order MAM/304/2002, of February 8, by that are published the operations of appraisement and elimination of residues and the European list of residues.

- Order on October 13, 1989 on methods of characterization of the toxic and dangerous residues.

STAGE I: MATERIAL BEHAVIOUR ON HUMAN HEALTH AND ENVIRONMENT.

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ANALITICAL RESULTS

ANALITO	RESULT	INTERPRETATION
Barium	4 mg /Kg m.s.	Presence
Cobalt	211 mg /Kg m.s.	Presence
Copper	34 mg /Kg m.s.	Presence
lead	18 mg /Kg m.s.	Presence
Zinc	16642 mg /Kg m.s.	Presence
Benzene *	10 µg/Kg	Presence
Trichloroethene *	8 µg/Kg	Presence
Toluene *	64 µg/Kg	Presence
m+p xylene *	40 µg/Kg	Presence
Sytirene *	17 µg/Kg	Presence
Linear hydrocarbons sum**	753 µg/Kg	Presence
Cyclic hydrocarbons sum**	1115 µg/Kg	Presence
Polycyclic Aromatic Hydrocarbons (1)**	192 mg /Kg m.s.	Presence

STAGE I: MATERIAL BEHAVIOUR ON HUMAN HEALTH AND ENVIRONMENT.

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ANALITICAL RESULTS

ANALITO	RESULT	INTERPRETATION
Barium	4 mg /Kg m.s.	Presence
		Presence
		Presence
		Presence
		Presence
		Presence
		Presence
		Presence
		Presence
		Presence
		Presence
		Presence
Polycyclic Aromatic Hydrocarbons (1)**	192 mg /Kg m.s.	Presence

- According to the R.D. 952/1997, though it is not a residue, since the last purpose of this recycled material is not the elimination, the presence of anyone of the substances detected (metals and organic compounds) in the sample awards character of dangerousness

STAGE I: MATERIAL BEHAVIOUR ON HUMAN HEALTH AND ENVIRONMENT.

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ANALITICAL RESULTS (2)

ANALITO	RESULT	INTERPRETATION
Agents oxidizers / reactivities in contact with water	Negative	H1 y H2. NEGATIVE Not explosive /Not comburent
Ignition point	> 75º C	H3. NEGATIVE Not flammable
pH	6.77 U pH	H4. NEGATIVE Not irritant
Irritability	Negative	H4. NEGATIVE Not irritant
Dermal and oral toxicity in rates	Not harmful/ Not toxic	H5 Y H6. NEGATIVE Not harmful / Not toxic
Carcinogenesis: search in bases of information of I.A.R.C. (International Agency for Research on Cancer)	<1% In weight for carcinogenic of group 3 and < 0.1 % In weight for carcinogenic of group 1 or 2	H7. NEGATIVE Not carcinogenic
Ames test	Not toxic / No mutagenic	H10 Y H11. NEGATIVE Not toxic for reproduction / Not mutagenic
Sulphurs / reactive cyanides	<100 mg/Kg / < 50 mg/Kg	H12. NEGATIVE Absence of substances that emit toxic or very toxic gases
Leaching study	H13. Studied in Stage III	
Echotoxicity test	5488 mg/L	H14. NEGATIVE Not dangerous for the environment

STAGE I: MATERIAL BEHAVIOUR ON HUMAN HEALTH AND ENVIRONMENT.

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ANALITICAL RESULTS (2)

ANALITO	RESULT	INTERPRETATION
Agents oxidizers / reactivities in contact with water	Negative	H1 y H2. NEGATIVE Not explosive /Not comburent
Ignition point	> 75º C	H3. NEGATIVE Not flammable
pH	6.77 U pH	H4. NEGATIVE Not irritant
		H4. NEGATIVE Not irritant
	oxic	H5 Y H6. NEGATIVE Not harmful / Not toxic
	enic of ight for	H7. NEGATIVE Not carcinogenic
	genic	H10 Y H11. NEGATIVE Not toxic for reproduction / Not mutagenic
Sulphurs / reactive cyanides	< 50 mg/Kg	H12. NEGATIVE Absence of substances that emit toxic or very toxic gases
Leaching study	H13. Studied in Stage III	
Echotoxicity test	5488 mg/L	H14. NEGATIVE Not dangerous for the environment

- **The characteristics of dangerousness studied in the STAGE I are NEGATIVE**

STAGE I CONCLUSIONS

- **Due to the fact that the final use of the recycled rubber object of study is the landfill of sports surfaces installed in the exterior and before the absence of positive characteristics of dangerousness in environmental normal conditions, we can conclude that the behavior of the above mentioned material, in spite of its composition, does not induce any danger on the human health and the environment.**

STAGE II: LEACHING EFFECT ON SOIL

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LEGAL FRAMEWORK

- **In order to evaluate the leaching effects on soil that recycled tires rubber could generate, it is appealed to:**

  - Decision 2003/33/CE, of the Council, of December 19, 2002 by that there are established the criteria and procedures of admission of residues in the dumps according with the article 16 and to the attached II of the Board 1999/31/CEE (TWELVE núm. L 11, of January 16, 2003).
  - R.D. 849/86, by that the quality is regulated of spilt realized to Public Hydraulic Authority.
  - U.E.F.A. Design and Construction Recomendations

STAGE II: LEACHING EFFECT ON SOIL

ANALITICAL RESULTS

1. Effects on soil: study on solid

ENSAYO	RESULTADO	CLASIFICACIÓN 2003/33/CE
Carbono orgánico	15000 mg/Kg	Inferior a 30000 mg/Kg. INERTE
Suma de BTEX	0.137 mg/Kg	Inferior a 6 mg/Kg. INERTE
[illegible]	[illegible]Kg	Inferior a 1 mg/Kg. INERTE
[illegible]	[illegible]g	Superior a 500 mg/Kg NO INERTE

- The material overcomes the content in aliphatic hydrocarbons (C10-C40) to be considered as Inert Solid

ANALITICAL RESULTS (2)

2. Effects on soil. Study of leaching

ENSAYO	RESULTADO	CLASIFICACIÓN 2003/33/CE. Inertes	CLASIFICACIÓN 2003/33/CE. No Peligrosos
Antimonio	<0.02 mg/Kg	0.06 mg/Kg	0.7 mg/Kg.
Arsénico			
Bario			
Cadmio			
Cobre			
Cromo			
Molibdeno			
Níquel			
Plomo	<0.02 mg/Kg	0.5 mg/Kg	10 mg/Kg.
Selenio	<0.02 mg/Kg		0.5 mg/Kg.
Zinc	2.89 mg/Kg		50 mg/Kg.
Mercurio	<0.001 mg/Kg		0.2 mg/Kg.
Carbono Orgánico Disuelto	237.6 mg/Kg		800 mg/Kg.
Fenoles	1.55 mg/Kg	1 mg/Kg	-
Sólidos disueltos	560 mg/Kg	4000 mg/Kg	60000 mg/Kg.
Cloruros	<50 mg/Kg	800 mg/Kg	15000 mg/Kg.
Fluoruros	<1 mg/Kg	10 mg/Kg	150 mg/Kg.
Sulfatos	74 mg/Kg	1000 mg/Kg	20000 mg/Kg.

- The material overcomes the content in phenols to be considered as Inert Solid

STAGE II: LEACHING EFFECT ON SOIL

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STAGE II CONCLUSIONS

- **The material overcomes the maximum concentrations allowed in phenols and aliphatic hydrocarbons (C10-C40) to be considered as Inert Solid, And past to consider non danger material.**

- **The analyzed parameters carry out the limits stipulated by the R.D. 849/86, considering leaching as public hydraulic dump even in the most restrictive conditions gathered in the above mentioned national legislation.**

STAGE II CONCLUSIONS (2)

- **The composition of recycled rubber presents an high contain in zinc and carbon, among other compounds. In the first leaching is observed that none of the parameters listed in the UEFA recommendations exceeds the maximum values, with the exception of the carbon. The UEFA establishes a value limit for this parameter, following the methodology gathered in the norm CASH 18035-7:2002-06.**

Estudio del lixiviado bajo la norma DIN 18035-7:2002-06.

ENSAYO	RESULTADO	U.E.F.A.
Zinc	0.31 mg/L	0.5 mg/L
Carbono orgánico disuelto	11.59 mg/L	<20 mg/L

STAGE II: LEACHING EFFECT ON SOIL

STAGE II CONCLUSIONS (2)

- **The composition of recycled rubber presents an high contain in zinc and carbon, among other compounds. In the first leaching is observed that none of the parameters exceed the maximum values, with the exception of the zinc, which is a value limit for this parameter following the methodology gathered in the norm CASH 18035-7:2002-06.**

- **The material does not overcome the values limit of the UEFA recommendations**

Estudio del lixiviado bajo la norma DIN 18035-7:2002-06.

ENSAYO	RESULTADO	U.E.F.A.
Zinc	0.31 mg/L	0.5 mg/L
Carbono orgánico disuelto	11.59 mg/L	<20 mg/L

LEGAL FRAMEWORK

- **To evaluate the sports surface effect on the environment, they are considered two legislation or regulation types :**
  - European Legislation in force or proposal where values establish limit of the compounds analyzed in air environment.
    - Proposal of Board of the European Parliament and of the Council, relative to As, Cd, Hg, Ni and HAP's in air environment
    - Board 2000/69/CE of the European Parliament and of the Council, of November 16, 2000, about the values limit for benzene and monoxide of carbon in air environment. And transposition to the Spanish legislation
  - Limit values relative to public health published by international recognized agencies: ACGIH, OSHA, NIOSH, DFG and HSE.

STAGE III: EFFECTS ON AIR

SAMPLING PLAN

SAMPLING PLAN (2)

ANALYZED PARAMETERS SELECTION

- The studied compounds have been selected according with tests already realized on this material type, references provided by the client, where stands out the presence of organic origin parameters due to the nature of the rubber, and high contain in sulphur, that makes admissible to determine the possible presence of hydrogen sulphur. Therefore the analyzed parameters have been the following ones:

  - **Polycyclic aromatic hydrocarbons (HAP's)**, Picked up in PUF filter by means of captator (containers) of high volume.
  - Volatile Organic Compounds (VOCs), Picked up in passive captators (containers).
  - **Hydrogen sulphide** measured "in situ" using Dräger tubes.

STAGE III: EFFECTS ON AIR

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ANALITICAL RESULTS

VOLATILE ORGANIC COMPOUNDS

Parámetro	Resultados Obtenidos (µg/m^3)					V.L. (L.E.A.A) (µg/m^3)	V.L. (N.E.S.L.) (µg/m^3)
	P-2	P-3	P-4	P-5	P-6		
Benceno	0.28	0.38	<0.01	0.19	0.19	5	-----
Tolueno	0.66	3.11	2.26	1.51	1.13	-----	TLV=188000 MAK=190000
Etilbenceno	1.13	2.17		1.32	0.94	-----	TLV=434000 MAK=440000
m,p-xileno	3.48	4.42		3.11	3.39	-----	
o-xileno	2.54	2.99		1.79	2.17	-----	

- benzene does not overcome the limit value in air according to the Board 2000/69/CE= 5µg/m^3

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ANALITICAL RESULTS

POLYCYCLIC AROMATIC HYDROCARBONS

Parámetro	Resultados Obtenidos (ng/m^3)						V.L. (L.E.A.A) (ng/m^3)	V.L. (N.E.S.L.) (ng/m^3)
	P-1	P-2	P-3	P-4	P-5	P-6		
Acenafteno	0.32	0.21	0.14	0.16	0.03	0.27	-----	-----
Acenaftileno	0.21	0.13	0.07	0.07	0.03	0.09	-----	-----
Antraceno	0.46	0.43	0.25	0.22	0.02	0.19	-----	-----
Benzo-(g,h,i)-perileno	<0.52	<0.53	<0.54	<0.52	<0.52	<0.55	-----	-----
Benzo-a-antraceno	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-----	-----
Benzo-a-pireno	<0.52	<0.53	<0.54	<0.52	<0.52	<0.55	1[ab]	MAK=2000
Benzo-b-fluoranteno	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	-----	-----
Benzo-k-fluoranteno	<0.35	<0.35	<0.36	<0.35	<0.35	<0.37	-----	-----
Criseno	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-----	-----
Dibenzo-(a,h,)-antraceno	<0.35	<0.35	<0.36	<0.35	<0.35	<0.37	-----	-----
Fenantreno	6.93	6.40	4.00	3.07	0.64	4.87	-----	-----
Fluoranteno	1.14	0.83	0.86	0.51	0.10	0.75	2[C]	-----
Fluoreno	0.61	0.77	0.43	0.92	0.05	0.81	-----	-----
Indeno-(1,2,3-c,d)-pireno	<0.87	<0.88	<0.90	<0.87	<0.87	<0.92	-----	-----
Naftaleno	0.33	0.30	0.13	0.12	0.10	0.23	-----	-----
Pireno	4.17	2.20	2.22	1.51	0.30	2.06	-----	-----

STAGE III: EFFECTS ON AIR

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ANALITICAL RESULTS

POLYCYCLIC AROMATIC HYDROCARBONS

Parámetro	Resultados Obtenidos (ng/m^3)						V.L. (L.E.A.A) (ng/m^3)	V.L. (N.E.S.L.) (ng/m^3)
	P-1	P-2	P-3	P-4	P-5	P-6		
Acenafteno	0.32	0.21	0.14	0.16	0.03	0.27	-----	-----
Acenaftileno	0.21	0.13	0.07	0.07	0.03	0.09	-----	-----
Antraceno	0.46	0.43	0.25	0.22	0.02	0.19	-----	-----
Benzo-(g,h,i)-perileno	<0.52	<0.53	<0.54	<0.52	<0.52	<0.55	-----	-----
Benzo-a-antraceno	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-----	-----
Benzo-a-pireno	<0.52	<0.53	<0.54	<0.52	<0.52	<0.55	[ab]	MAK=2000
Benzo-b-fluoranteno	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	-----	-----
Benzo-k-fluoranteno	<0.35	<0.35	<0.35	<0.35	<0.35	<0.37	-----	-----
Criseno	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-----	-----
Dibenzo-(a,h,)-antraceno	<0.35	<0.35	<0.35	<0.35	<0.35	<0.37		
Pireno	4.17	2.20	2.22	1.51	0.30	2.06	-----	-----

- The benzo(a)pyrene does not overcome the limit value proposed by the European parliament = 5µg/m3 (maximum value legislated in Italy)

STAGE III: EFFECTS ON AIR

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ANALITICAL RESULTS

HYDROGEN SULPHIDE

Parámetro	Resultados Obtenidos (mg/m^3)					
	P-1	P-2	P-3	P-4	P-5	P-6
Hidrógeno sulfurado en aire "in situ"	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3

- **It is not detected hydrogen sulphide emission**

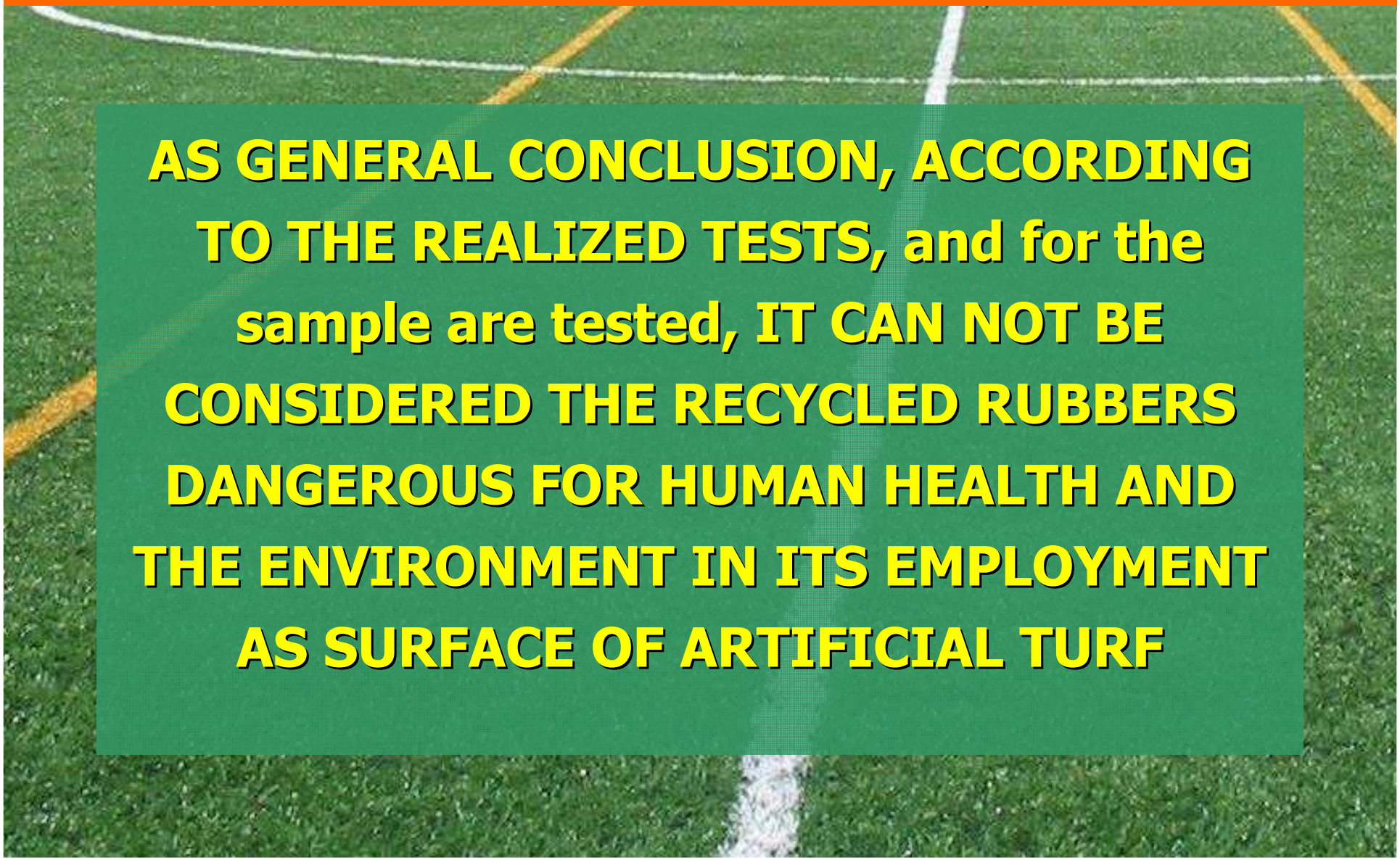
STAGE III: EFFECTS ON AIR

STAGE III CONCLUSIONS

- **The obtained results from the parameters analyzed in the effects on air study in the football field made of artificial turf do not exceed any maximum value established so much in the European legislation of air environment, since in the regulation of labour health gathered for the elaboration of the current report.**

- **The positive results obtained in the analysis of HAPs and VOCs picked up in the realized samples are similar to the emission generated by traffic in the zone of influence.**

- **There is not detected sulphurated hydrogen in the air sampled in the installation.**



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AS GENERAL CONCLUSION, ACCORDING TO THE REALIZED TESTS, and for the sample are tested, IT CAN NOT BE CONSIDERED THE RECYCLED RUBBERS DANGEROUS FOR HUMAN HEALTH AND THE ENVIRONMENT IN ITS EMPLOYMENT AS SURFACE OF ARTIFICIAL TURF