

## **Environmental Combatibility Concept according to DIN 18035 Test procedures and background**

SGS Institut Fresenius in Berlin have been dealing with the testing of artificial play grounds and infill material on the basis of recycled tyres for several years. The investigations of these materials are part of the German quality assurance. We were asked to inform about the German test procedure in line with the German norm DIN 18035.

Investigations of the release of hazardous substances in synthetic surfaces for indoor sport areas were commissioned by the German authorities in the 1990's. As a result, there were no relevant dangers on the basis of the release of "particulate dust". Volatile organic compounds and heavy metals by use of artificial playgrounds were not identified.

A draft of a standard exists for synthetic turf areas and synthetic surfaces since 2002 and respectively since 2004

- DIN E 18035-6 synthetic surfaces for outdoor sports areas
- DIN E 18035-7 synthetic turf surfaces for outdoor sports areas

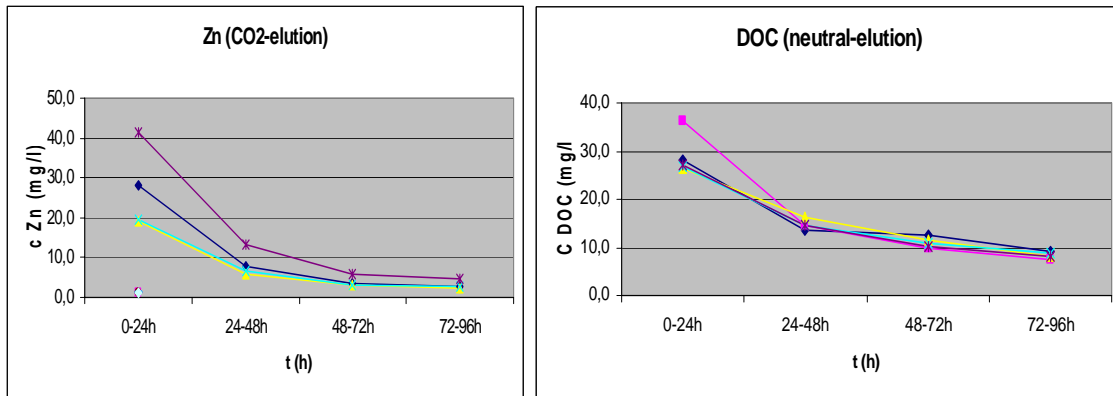
The aims for the environmental checks are, that the health of residents in the environment and users of this playground are not effected by release of hazardous volatile gases and particles in the air, ground- and surface water.

The Quality Assurance should fulfil these requirements. In general, we distinguish between performance tests by the producer and surveillance tests to achieve conformity of products. The Quality Assurance should fulfil these requirements. In general, we distinguish in environmental checks between performance tests and regulat tests to achieve conformity of products.

- the RAL Label GZ 943 from the German Institute for Quality Assurance and Labelling
- DINCertco – Institute for Conformity Assessment

Rubber products could contain a multitude of compounds, partly of very high concern. Substances that are used in large amounts are reinforcing agents such as carbon black, aromatic oils and solvents, vulcanisation agents, activators and metal compounds. Especially the spectrum of organic compounds is very complex. That's why the description of the release of water-soluble organic compounds is done by the lump parameter DOC. Chlorinated paraffin and other halogenated organic compounds in rubber products can sometimes be found, which are detected also by the lump parameter EOX. Long-range soluble heavy metals are determined by an acid elution with permanent CO<sub>2</sub>-gassing according to a Swiss waste investigation method. Additionally, a neutral elution with a L/S ratio 10:1 characterized the amounts of easily available Zinc cations.

The used 48 h elution is very different from the commonly applied 24 h-elution method in soil and waste investigation. The goal of the 24h up to 48 h elution is the recording of the mobilisation of dangerous compounds and not the recording of a short-term soluble peak. As you can see in the charts, during the first 24 h there are brief disposels of organic compounds and Zn, which is shown for the leachate behaviors of selected tyre granules.



The next point is the toxicity test. The Nitrification test or luminescence bacteria test will be used for the examination of the toxicity in the 48 h neutral elution. Currently, there are no assessments in the field of synthetic surfaces and infill materials in synthetic turf areas. The toxicity assay is needed only for elastic baselayers and synthetic turf.

The preparation of test bodies (2 cm edge length) of the synthetic surfaces is of great importance. The cutting edges must be sealed by a binder, so that only the mobilisation of the surfaces can be recorded.

The assessment is based on the German Legislation. Limiting values for heavy metals and organic lump parameters are derived from the German Soil Protection law and the guide for recycling of mineral products. Groundwater is the point of compliance for both.

The groundwater quality is also the focus of testing according DIN 18035. Currently, there are no requests to investigate the release of particulate dust, volatile organic compounds and organic compounds in skin contact such as PAH. This method will be confirmed by current studies especially from Scandinavia. Individual investigations of amount and composition of PM 10 / PM 2,5 particular dust and the VOC releases have shown, that the release of hazardous substances in the air to be of little importance versus an exposure of the soil/ground water-system. On the next Chart there are the environmental requirements according to DIN 18035, on the left side for synthetic turf areas, on the right side for synthetic surfaces. According to DIN 18035-7 the turf, the infill material and the elastic base layer is tested separately. The measurement of Zn in neutral eluat is carried out only for the infill material. The toxicity assay is needed only for elastic baselayers and synthetic turf. Synthetic surfaces and infill materials in synthetic turf areas currently will only be investigated for collection of experience.

parameter	synthetic turf surfaces			synthetic surfaces		
	origin [mg/kg]	48 h leachat neutral [mg/l]	48 h leachat acid [mg/l]	origin [mg/kg]	48 h leachat neutral [mg/l]	48 h leachat acid [mg/l]
DOC		< 20 / < 40			< 20 / < 40	
EOX	<100			<100		
Pb			<0.04			<0.04
Cd			<0.005			<0.005
Cr			<0.05			<0.05
Cr-VI			<0.008			<0.008
Hg			<0.001			<0.001
Zn		< 0,5*	< 3			< 3
Sn			<0.05			<0.05
Toxicity			< 50 %**			collection experience

On the next chart the assessment of the concentrations is documented according to DIN 18035. For the organic lump parameters DOC a range of 20 up to 40 mg/l is tolerable, if the concentration of EOX exceeds the 100 mg/kg level there is an elimination of the use as well as the indicated concentrations for DOC > 40 mg/l or Zn > 1 in neutral respectively > 20 mg/l in acid leachat. The last point is only valid for infill materials.

parameter	48 h leachat neutral [mg/l]	48 h leachat acid [mg/l]	remark	ko condition
DOC	> 20 / < 40 > 40		consideration EOX	x
EOX				EOX > 100 mg/kg
Zn *	> 0.5 / < 1.0		tolerable	
		> 3.0 / < 20.0	tolerable	
	> 1			x
		> 20		x

The following generalisations from the multitude of existing results are possible.

In general for turf material there are no difficulties. The toxicity is clearly less than 50 %. In individual cases we found a DOC larger than 20 mg/l or sometimes larger than 40 mg/l. Perhaps it's caused by oils in the production process. Zn is not a problem for turf. Sometimes we found Zn in the bottom of the fabric, possible caused by latex coating.

In general base layers contain tire granules in bigger pieces than the infill material, which is bonded in polyurethane. That's why, we found low concentrations of Zn and DOC and no toxicity.

In the case of infill material we distinguished in SBR, EPDM und thermoplastic tyre material. Technical and agricultural used tyre products (SBR) should be banned, here we found partly extrem Zn-concentrations in neutral and acid leachates. 75 % of all of the investigated SBR infill materials are nontoxic (<50 %). By the majority the zn-values are kept in neutral and acid leachates

Sulphur linked EPDM contain lower than 0.2 % Zn, but all the samples are toxic in the luminescence bacteria test, probably by benzothiazolic compounds.

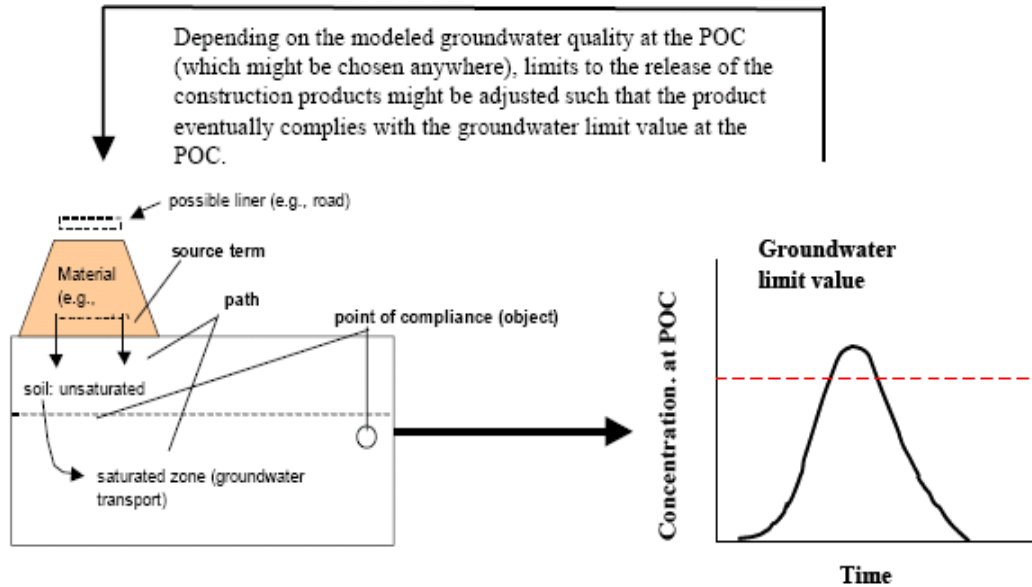
Peroxid linked EPDM contain barely Zn and there are not toxic. In some cases we found DOC in the range up to 40 ppm, probably caused by monomers. In the analysis of thermoplastics there are only a little number of investigated samples. In all cases we found for each parameter no exceeding of the limiting values.

All requirements are fulfilled for synthetic surfaces. But it should be noted, that all the samples are toxic in the luminescence bacteria test, probably by benzothiazolic compounds. Currently, there is no assesment for synthetic surfaces.

What are the points of criticism from the literature?

1. The question is if the measured concentrations by the used extraction methods are comparable to the amounts that are released from sports areas after each rainfall.
2. The importance of the use of CO<sub>2</sub> saturated water as an extraction solvent is questioned.
3. The preparation method of test bodies (edge length of 2 cm) is very complicated and prone to errors.
4. The importance of the use of toxicity tests is questioned

The general question is, where is the point of compliance: ground water or quality of the leachate. The German soil protection law uses the concept of "threshold value". The threshold value for Zn is 0,5 mg/l. If the concentration of Zn exceeds the 0.5 mg/l-level actions must be taken. In the view of the precautionary principle, the layer between saturated and unsaturated zone as the point of compliance is unacceptable. The soil protection law appoints the leachat as the point of compliance. This approach complies with the German concept of the reutilisation of soils and construction debris, in which the limiting values for Zn in the region of 0.15 up to 0.6 mg/l depends on the contamination sensitivity of the ground water.



One point of criticism is the elution with CO<sub>2</sub> saturated Water. The aim for this test is the determination of the long-term mobilised concentration of heavy metals. This method of a pH dependance elution is accepted in the new european directions for example in the investigation of waste or construction materials . Specially for the charakterisation of granular products the pH-dependence test is recommended. But it's true, nobody uses the antiquated method with CO<sub>2</sub> saturated water anymore.

test	brief description	level
prEN14429	<b>pH-dependence test</b> , on granular or size reduced products	characterisation
prEN14405	column test, on granular products	characterisation
EN12457-2	batch test (natural pH), granular products	compliance
EN12457-3	serial batch test, granular products	characterisation
wi292040	dynamic monolith leaching test (DMLT, tank test)	characterisation
wi292010	compliance tests, monoliths	compliance
EN1250	tank test for preserved wood (monoliths)	compliance

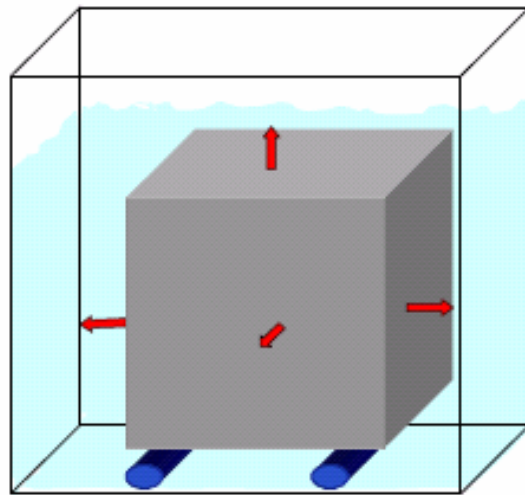
The preparation of test bodies by sealing is indeed complicated but necessary concerning mentioned causes. It should be considered, that by a modification of the sample size a sealing is not necessary. For example a change of the size from a edge lengt 2 cm up to 20 cm reduces the impact of the sealing failure to about the factor to 10. This procedure requires a new elution procedure according to the test described in a current ECN-study.

**TEST CONDITIONS:**

First step: pre-equilibration  
for 48 hrs at liquid to  
volume ratio: 5

Second step: leaching  
at low L/V ratio (1) for 24 hrs  
Then contact times: 2, 4, 8, 16, 32 and 64 days  
Leachant: demineralised water (own pH)

Expression of results in  $\text{mg}/\text{m}^2$  (cumulative) against time  
CGLT = Compacted Granular Leach Test



In Germany soil and ground water assessment toxicity tests will play a growing role. Currently in Germany there is a new soil protection law in the pipeline including toxicity tests. 86 terrestrial and 26 aquatic test systems are checked at the moment. The problems of generalisation from the lab into the environmental systems are known and demand furthermore research. Currently it's possible, that luminiscense bacteria, daphnia and green alga tests are relevant for the path soil into groundwater

What is the outlook for the future on my opinion?

The German proposal should be discussed in the context of the upcoming European standardisation in the field of TC 217; workgroup 6

A change of the elution methods is necessary. The Percolation method such as CEN/TS 14405 should be considered as well as the batch test such as EN 12457 for L/S ratio from 2 or 10 l/kg.

It is be wise to change the method for the characterisation from the saturated CO<sub>2</sub> Elution-test into the pH-dependence test such as prEN 14429.

The use of the tank test in the field of elution monolithic products such as synthetic surfaces is recommended. By the change of the sample size sealing failuers become marginal.

There is no necessity to exceed the parameter list for investigation. The lump parameters DOC as a marker for the leaching organic compound is useful. Perhaps it would be wise to

connect the necessity for an toxicity test with the result of the DOC. It's imaginable to use a luminescens bacteriaria test with an attenuation level GL 8, if the DOC exceeds the 10 ppm-level.

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