Sports Turf Alternatives Assessment: Preliminary Results
CHEMICALS IN ALTERNATIVE SYNTHETIC INFILLS: EPDM

Massachusetts Toxics Use Reduction Institute
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Introduction

The Massachusetts Toxics Use Reduction Institute (TURI) conducts alternatives assessments as part of its overall mission to help Massachusetts companies, communities, and municipalities identify and implement toxics use reduction options that will provide safer solutions to the use of toxic chemicals.

TURI has received numerous requests for information about artificial turf fields as an alternative to natural grass fields. In response, TURI is developing an alternatives assessment for sports turf. Preliminary sections of the assessment are being published in the order in which they are developed.

The section presented here covers information on chemicals found in one type of synthetic infill: ethylene propylene diene terpolymer (EPDM). EPDM is marketed as an alternative to crumb rubber made from recycled tires (also referred to as styrene butadiene rubber, or SBR). Information for this section has been drawn from government agency reports, peer reviewed literature and industry publications. This information may be updated over time as new information becomes available.

For background on the types of materials that can be used in infills, as well as the regulatory standards that are sometimes referenced by manufacturers and others, see "Chemicals in Artificial Turf Infill: Overview."[1]

EPDM: Material description

EPDM rubber is a specialty elastomer: a polymer with elastic or rubber-like characteristics. EPDM has a number of useful physical characteristics, including the ability to be mixed with high levels of additives and oils while retaining its desirable physical properties, including strength and resistance to tearing. Additives can include oil, carbon black, and other mineral materials. EPDM may be manufactured with anywhere from 15 to 100 parts of oil per 100 parts of polymer. [2]

EPDM infills are available from several manufacturers. Table 3 shows a summary of several brands we were able to identify as of publication of this report. This list is not intended to be comprehensive. New brands may enter the market frequently.

Table 3: EPDM infill products

Manufacturer	Brand Name	Tests referred to on website (examples)
Melos	Melos Infill EPDM ECO	German artificial turf standard (DIN 18035-7); German PAH content standard (AfPS GS 2014:01 PAK); EU toy

		safety standard (EN 71-3); Austrian standards for ecotoxicity (luminescent bacteria test) and nitrification inhibition.
Melos	Melos Bionic Fibre	German artificial turf standard; German PAH content standard; EU toy safety standard.
Gezolan	Gezofill; Gezoflex	German standard for organically bound halogens (DIN 38414-17); EU toy safety standard.
TTII	TTII Play-Safe 65 EPDM Infill	Proposition 65; EU toy safety standard

Sources:
Melos. "Melos Infill EPDM ECO." Information sheet available at https://www.melos-gmbh.com/fileadmin/templates/downloads/granules/infill/Infill_Granules_EN/infosheet-infill-epdm-eco-en.pdf, viewed October 25, 2016.
Melos. "Infill Bionic Fibre – the new generation of infill granules for artificial turf." Information sheet available at https://www.melos-gmbh.com/fileadmin/templates/downloads/granules/infill/Infill_Granules_EN/infosheet-infill-bionic-fibre-en.pdf, viewed October 25, 2016.
Gezolan. "Gezofill: EPDM for Infill Systems." Web page available at http://www.gezolan.ch/en/gezofill/, viewed October 25, 2016. Information also drawn from Technical Data Sheet available at http://www.gezolan.ch/wp-content/uploads/download/en/TDB%20GFill%200525LD%20EN.pdf, viewed October 27, 2016.
TTII. TTII Play-Safe 65 EPDM Infill: Specification Sheet. Available at http://www.ttiionline.com/wp-content/uploads/2015/05/PLAY-SAFE-EPDM-65-Infill-Spec-Sheet.pdf, viewed October 24, 2016.

Recycled rubber granulate vs. EPDM infill: Norwegian Building Research Institute

A 2004 study by the Norwegian Building Institute (NBI) examined levels of selected chemicals in EPDM infill, comparing these levels with those found in samples of recycled rubber granulate. (Note: The study does not state specifically whether the recycled rubber granulate was derived from waste tires, although it seems reasonable to assume that this is the case.) The study found that the EPDM contained lower levels of the tested chemicals than recycled rubber granulate, but did contain some chemicals of concern. The authors state that "with the exception of chromium and zinc, the EPDM rubber contains lower concentrations of hazardous substances than the recycled rubber types overall."[3]

Findings – summary. NBI compared one sample of EPDM granulate with three samples of recycled rubber granulate. The study found that the EPDM rubber contained "more chromium than the recycled rubber types," similar amounts of zinc, and lower concentrations of "PAH, phthalates, and phenols." PCBs, which were found in one sample of recycled rubber, were not found in the EPDM.

Chromium and zinc. The authors note that the chromium and zinc levels in the EPDM "exceed the Norwegian Pollution Control Authority's normative values for most sensitive land use," defined as areas intended for "housing, gardens, nurseries, schools, etc." Zinc levels in leachate from the EPDM correspond to the Norwegian Pollution Control Authority's "Leaching Class IV (strongly polluted)," while the chromium levels correspond to "Environmental Quality Class II (moderately polluted)."[4]

PAHs. The NBI study also examined PAHs in the samples. PAH levels in EPDM over all were found to be much lower than those in the recycled rubber, but a few PAHs were detected at low levels: naphthalene, phenanthrene, fluoranthene, pyrene, and benzo(a)pyrene. For benzo(a)pyrene, levels in recycled rubber ranged from 2.4 to 3 mg/kg, while the level in EPDM was 0.12.[5]

Phthalates. A number of phthalates were detected in the EPDM. Dimethylphthalate (DMP) and diethylphthalate (DEP) and di-n-octylphthalate (DOP), which were below the detection level in the recycled rubber, were present at 3.4 mg/kg, 1.5 mg/kg and 3.2 mg/kg, respectively, in the EPDM. Dibutylphthalate (DBP) and diethylhexylphthalate (DEHP) were detected in both recycled rubber and EPDM, although DEHP levels were much lower in the EPDM than in the recycled rubber samples. [6]

VOCs. When heated to 70 degrees C, the EPDM released lower levels of VOCs into air than the recycled rubber. VOCs detected by the researchers in this test included toluene, propylbenzene, 1,2,4-trimethylbenzene, and cis-1,2-dichloroethene. All were at lower levels than those found for the same chemicals in the recycled rubber granulate. Eight other VOCs that were found in one or more recycled rubber samples were below the detection threshold in the EPDM sample. [7]

Table 4, below, summarizes these findings.

Table 4: Comparison: Recycled Rubber Granulate vs. EPDM infill (NBI 2004)

		Recycled rubber granulate (n=3)	**EPDM (n=1)**
PAHs	Total PAHs	Yes (16 PAHs detected; total PAHs 51 to 76 mg/kg)	Yes (5 PAHs detected; total PAHs 1 mg/kg)
Phthalates	Phthalates – over all	Yes	Yes (lower)
	Dimethylphthalate (DMP)	No*	Yes (3.4 mg/kg)
	Diethylphthalate (DEP)	No*	Yes (1.5 mg/kg)
	Dibutylphthalate (DBP)	Yes (2.6 to 3.9 mg/kg)	Yes (1.6 mg/kg)
	Benzylbutylphthalate (BBP)	Yes (1.3 to 2.8)	No*
	Diethylhexylphthalate (DEHP)	Yes (21 to 29 mg/kg)	Yes (3.9 mg/kg)
	Di-n-octylphthalate (DOP)	No*	Yes (3.2 mg/kg)
	Diisononylphthalate (DINP)	Yes (57 to 78 mg/kg)	No data
	Diisodecylphthalate	No*	No data
Phenols	Phenols – over all	Yes	Yes (lower)
	4-t-octylphenol	Yes (19,600 to 33,700 µg/kg)	Yes (49.8 µg /kg)
	Iso-nonylphenol	Yes (9120 to 21,600 µg /kg)	Yes (1120 µg /kg)
VOCs (offgassing test)		Yes (12 detected)	Yes (4 detected, all at lower levels than the recycled rubber granulate)

Source: Norwegian Building Research Institute (NBI - BYGGFORSK). 2004. "Potential Health and Environmental Effects Linked to Artificial Turf Systems: Final Report." Report prepared for the Norwegian Football Association. Project no. 0-10820. September 10, 2004. Authors: Thale S.W. Plesser, Ole J. Lund.
* Below detection limit of 1 mg/kg

Metals. The researchers tested the samples for arsenic, lead, cadmium, copper, chromium[1], mercury, nickel and zinc. Of these, arsenic and nickel were below the detection limit in all samples. As shown in Table 5, below, lead and zinc were detected in all the samples. Cadmium and copper were detected in all the recycled rubber samples but were below the detection limit in

[1] Some resources specify whether the discussion refers to trivalent, hexavalent, or total chromium. The NBI report does not specify whether NBI considered trivalent and hexavalent chromium separately, but based on the information NBI provides about the test used (ISO 11885:2007), it is reasonable to assume that NBI focused on total chromium.

the EPDM sample. Chromium was below the detection limit in the recycled rubber sample, but present in the EPDM sample. Mercury was detected in two of the recycled rubber samples, and was below the detection limit for one recycled rubber sample and for the EPDM sample. Zinc was present in all samples.

Table 5 Comparison: Recycled Rubber Granulate vs. EPDM infill: Metals (NBI 2004) (mg/kg)

	Recycled rubber granulate (n=3)	**EPDM (n=1)**
Lead	15 to 20	8
Cadmium	1 to 2	<0.5
Copper	20 to 70	<3
Chromium	<2	5200
Mercury	0.04 (two of three samples)	<0.03
Zinc	7,300 to 17,000	9,500

Source: Source: Norwegian Building Research Institute (NBI - BYGGFORSK). 2004. "Potential Health and Environmental Effects Linked to Artificial Turf Systems: Final Report." Report prepared for the Norwegian Football Association. Project no. 0-10820. September 10, 2004. Authors: Thale S.W. Plesser, Ole J. Lund.

Specific EPDM infill products

In order to gain greater clarity about the composition of EPDM infills on the market, TURI examined additional information on three EPDM infill products. These products were selected as examples based on a simple internet search, and are not necessarily representative of other EPDM infill products.

TTII EN-71 testing. Target Technologies International, Inc. (TTII) provides information online about its Play-Safe 65 EPDM Infill.[8]

TTII provides testing results for a sample of the Play-Safe 65 EPDM Infill to check for compliance with the European Standard EN 71-3 – Safety of Toys Part 3: Migration of Certain Elements (EN 71-3). (For background on this standard, see "Chemicals in Artificial Turf Infill: Overview."[9]) All the chemicals except zinc are shown to be below the sample detection limit for this test, although the sample detection limit is relatively high. For example, the sample detection limit for arsenic is 5 mg/kg, while the EN-71 Category 1 standard is 3.8 mg/kg, making it impossible to determine whether the standard is met. Similarly, the sample detection limit for hexavalent chromium is 0.1 mg/kg, while the EN-71 Category 1 standard is 0.02; and the sample detection limit for mercury is 10 mg/kg, while the EN-71 Category 1 standard is 7.5 mg/kg.[10]

The sample detection limit for lead is 10 mg/kg, which is sufficient to show compliance with the EN-71 Category 1 standard of 13.5 mg/kg. [11] Nonetheless, many decision makers may be interested in a greater level of specificity regarding total lead content in the product.

TTII Proposition 65 testing. TTII also provides test data on a number of semivolatile organic compounds (SVOCs) and metals for which disclosure is required under California's Proposition

65. Of 19 SVOCs included in the test, just two were detected: fluoranthene at 1.4 mg/kg and pyrene at 8.3 mg/kg. (Detection limits for these tests were variable; most were in the range of hundreds of micrograms/kg, while two were above 1 mg/kg.[12])

Of 19 metals included in the test, 7 were detected: aluminum, barium, chromium, iron, manganese, tin, and zinc. Of these, the zinc level was highest by far, at 6,610 mg/kg. [13]

FieldTurf EN-71 testing. FieldTurf has developed test data for its EPDM infill product using the EN 71-3 standard.[14] FieldTurf provides data for a product referred to as "ARC EPDM." This product is not, however, currently advertised on FieldTurf's website.[15]

Of the 19 metals tested for, 10 were detected in the ARC EPDM sample: aluminum, barium, boron, chromium, copper, lead, manganese, nickel, strontium, and zinc.

Comparing the test results to the Category 1 standard, the ARC EPDM sample meets the standard for some but not all of these metals. Specifically, the test results show a finding of 17.3 mg/kg lead. The Category 1 standard for lead is 13.5 mg/kg, so it fails this standard. (The category 2 standard is even lower, at 3.4 mg/kg.)

For chromium, the sample meets the standard for trivalent chromium. Hexavalent chromium is shown to be nondetectable with a detection limit of 0.2 mg/kg. The Category 1 standard for hexavalent chromium is 0.02 mg/kg (and the Category 2 standard is even lower, at 0.005), so it is not possible to determine from this information whether the standard is met. The lab report does also provide a "chrome total" figure of 0.75. Tin is shown as nondetected with a detection limit of 0.5 mg/kg; it is not clear whether a test for organic tin was conducted.

Gezofill. Gezolan, manufacturer of Gezofill infill, provides the following information on additives used in its 0.5 – 2.5 mm, low-density, colored EPDM infill. It notes that the additives include "mineral fillers, paraffinic mineral oil, processing aids, dy[e]stuffs and [sulphur based] crosslinking agents."[16] Similarly, another Gezolan data sheet, for "Gezoflex and Gezofill EPDM granules," characterizes the material as "vulcanised rubber mixture based on EPDM (ethylene propylene diene monomer (M-class) rubber), natural mineral fillers, paraffinic mineral oils, dyes, vulcanisation and processing agents, antioxidants."[17]

Gezolan also provides information on the level of 16 PAHs in its infill. All the PAHs tested are found to be below 0.1 mg/kg, and the total PAH level is 1.6 mg/kg.[18]

Boundaries of this chapter

As a reminder, this chapter *only* includes information on chemicals that may be found in EPDM infill. It does not include an examination of other topics that could be important, such as the

potential of the material to create fine particles. Technical characteristics of the infill, including durability, are also not discussed here.

Information on heat-related concerns are covered in a separate chapter. It is important to note that in general, all synthetic turf fields reach higher temperatures than natural grass fields, regardless of infill type.

Summary

In summary, regarding chemicals specifically, EPDM infill is likely to contain some chemicals of concern, although it may contain fewer chemicals of concern than SBR made from recycled tires. In the FieldTurf sample for which data are available, lead appears to be a particular concern.

The Toxics Use Reduction Institute is a multi-disciplinary research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989. The Institute sponsors and conducts research, organizes education and training programs and provides technical support to help Massachusetts companies and communities to reduce the use of toxic chemicals.

In response to information requests from municipalities, TURI is currently developing a detailed alternatives assessment for sports turf. Preliminary sections of the assessment are being published in the order in which they are developed, and are available on TURI's website at www.turi.org.

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[1] Toxics Use Reduction Institute (TURI). 2017. "Sports Turf Alternatives Assessment: Preliminary Results: Chemicals in Artificial Turf Infill: Overview." All TURI documents on artificial turf can be found at: http://www.turi.org/Our_Work/Home_Community/Artificial_Turf.
[2] Kroschwitz, Jacqueline I., ed. 1990. *Concise Encyclopedia of Polymer Science and Engineering*. New York: John Wiley & Sons. Ormonde, E., Yoneyama, M., Xu, X. 2015. "Ethylene-Propylene Elastomers." *Chemical Economics Handbook.* CEH Report #525.2600. Houston, TX: IHS Chemical.
[3] Norwegian Building Research Institute (NBI - BYGGFORSK). 2004. "Potential Health and Environmental Effects Linked to Artificial Turf Systems: Final Report." Report prepared for the Norwegian Football Association. Project no. 0-10820. September 10, 2004. Authors: Thale S.W. Plesser, Ole J. Lund.
[4] NBI 2004.
[5] NBI 2004.
[6] NBI 2004.
[7] NBI 2004.
[8] TTII. No date. TTII Play-Safe 65 EPDM Infill: Specification Sheet. Available at http://www.ttiionline.com/wp-content/uploads/2015/05/PLAY-SAFE-EPDM-65-Infill-Spec-Sheet.pdf, viewed October 24, 2016.
[9] Toxics Use Reduction Institute (TURI). 2017. "Sports Turf Alternatives Assessment: Preliminary Results: Chemicals in Artificial Turf Infill: Overview." All TURI documents on artificial turf can be found at: http://www.turi.org/Our_Work/Home_Community/Artificial_Turf.
[10] Sports Labs USA. 2016. "Laboratory Testing: Heavy Metals Analysis." Tests conducted for Target Technologies International Inc., February 26, 2016. Available at http://www.ttiionline.com/wp-content/uploads/2015/05/PLAY-

SAFE-65-EPDM-EN71-3-Safety-of-Toys.pdf, viewed October 25, 2016. European Standard EN 71-3:2013+A1. October 2014. ICS 97.200.50. *Safety of Toys – Part 3: Migration of Certain Elements.* Available at https://law.resource.org/pub/eu/toys/en.71.3.2015.html, viewed October 4, 2016.

[11] Sports Labs USA. 2016. "Laboratory Testing: Heavy Metals Analysis." Tests conducted for Target Technologies International Inc., February 26, 2016. Available at http://www.ttiionline.com/wp-content/uploads/2015/05/PLAY-SAFE-65-EPDM-EN71-3-Safety-of-Toys.pdf, viewed October 25, 2016. European Standard EN 71-3:2013+A1. October 2014. ICS 97.200.50. *Safety of Toys – Part 3: Migration of Certain Elements.* Available at https://law.resource.org/pub/eu/toys/en.71.3.2015.html, viewed October 4, 2016.

[12] Eurofins Lancaster Laboratories Environmental. 2015. "Analysis Report." Prepared for Ecore International, January 8, 2015. Available at http://www.ttiionline.com/wp-content/uploads/2015/05/PLAY-SAFE_65_EPDM_Prop-65-Metals_Test_Report.pdf, viewed October 27, 2016.

[13] Eurofins Lancaster Laboratories Environmental. 2015. "Analysis Report." Prepared for Ecore International, January 8, 2015. Available at http://www.ttiionline.com/wp-content/uploads/2015/05/PLAY-SAFE_65_EPDM_Prop-65-Metals_Test_Report.pdf, viewed October 27, 2016.

[14] Labosport. 2014. *Technical Report: Toxicological Analysis of performance infill for synthetic turf fields according to EN 71-3 standard – Safety of toys Part 3: Migration of certain elements.* Report Number: R14565CAN-A1, December 12, 2014. Provided via email by Darren Gill, Vice-President – Marketing, Innovation, Customer Serivce, FieldTurf, August 11, 2016.

[15] FieldTurf. (No date.) "Infill Systems." Web page available at http://www.fieldturf.com/en/infill-systems, viewed October 27, 2016.

[16] Gezolan. 2016. "Technical Data Sheet: 0.5 -2.5 mm, coloured EPDM Rubber Granulate: Low Density Version." Available at http://www.gezolan.ch/wp-content/uploads/download/en/TDB%20GFill%200525LD%20EN.pdf, viewed October 27, 2016.

[17] Gezolan. 2014. "Datasheet concerning the safe handling of Gezolan EPDM granules." Available at http://www.gezolan.ch/wp-content/uploads/download/en/MSDS%20English.pdf, viewed October 27, 2016.

[18] Gezolan 2016.