VOLATILE AND SEMIVOLATILE CONTAMINANTS IN CRUMB RUBBER INFILL OF SYNTHETIC TURF

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SCOPE and MOTIVATION

The enormous production of end-of-life tires (ELTs) worldwide poses a problem of how to dispose of this type of waste. Plain dumping or incineration are common practices, but its valorization is also contemplated recently. One of the ways found is to take the tire rubber and shred it to crumb rubber, that can be used in several applications like turf infill in synthetic football fields. However, this material carries with it many potentially hazardous chemicals, mostly from the tire manufacturing process.

AIMS

In this work, performed under **Project SAFEGOAL**, we review the levels of VOCs, PAHs, metals and other related contaminants in crumb rubber from turf infill. This issue is particularly important in indoor facilities, where the human exposure to these chemicals and the odors associated, many of them VOCs, are increased due to poorer ventilation and the high temperatures of these closed places. This study is in line with recent reports by the USEPA and ECHA recommendation of more research to assess thoroughly the possible impacts of crumb rubber to human health.

LITERATURE REVIEW

Highest concentration

PAHs

BaA/CR	n.d. – 7.96±0.09 mg/kg
CHR	n.d. – 3.20±1.42 mg/kg
BbF	n.d. – 6.60±0.71 mg/kg
BkF	n.d. – 2.51±0.10 mg/kg
IcP	n.d.
BaP	n.d. – 4.08±4.49 mg/kg
BghiP	n.d. – 7.80 mg/kg
DBA/ICR	n.d. – 3.47±0.03 mg/kg
8-carcinogenic	2.10±1.96 – 24.67±18.32 mg/kg
Total EPA16	20.43±11.32 – 76.3 mg/kg

BaA/CR and CHR: Rubber crumb should not contain more than 1 mg/kg of any of the listed 8-carcinogenic PAHs.

Metals

It is known that tire treads have in their composition heavy metals such as Pb, Cd, Zn, Ni, Cu, Fe, Mn and Co.

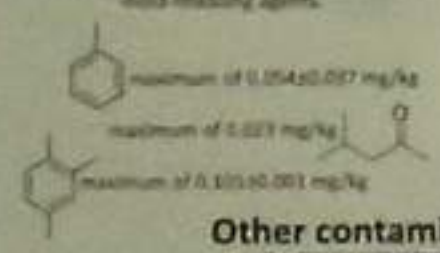
Zn (n.d. to 14150.0±1343.5 mg/kg)
Fe (305 to 2744.0 mg/kg)
Co (n.d. to 184.0±38.2 mg/kg)

Other elements: Al>Mg > Mn>Pb > Cu

Only one study reported macro-elements.

VOCs

Coming from the solvents used in the rubber conversion industry, used to bind different layers of rubber or rubber coated components and as mold releasing agents.



Other contaminants

Plasticizers – DEHP – 25.0±0.7 mg/kg

Antioxidants and additives – 4,4'-cyclohexylidenebisphenol – 26.0±0.08 mg/kg

PCBs – PCB28 – 0.0002±0.00 mg/kg

Most of the compounds identified and quantified in crumb rubber have already been associated to health human concerns. For example, PAHs are linked with cancer risk and organ damage, metals could damage the nervous system, as well as irritation of the eyes, nose and throat, and VOCs are related with organ damage or specific symptoms such as headaches, nausea and sense organ irritation.

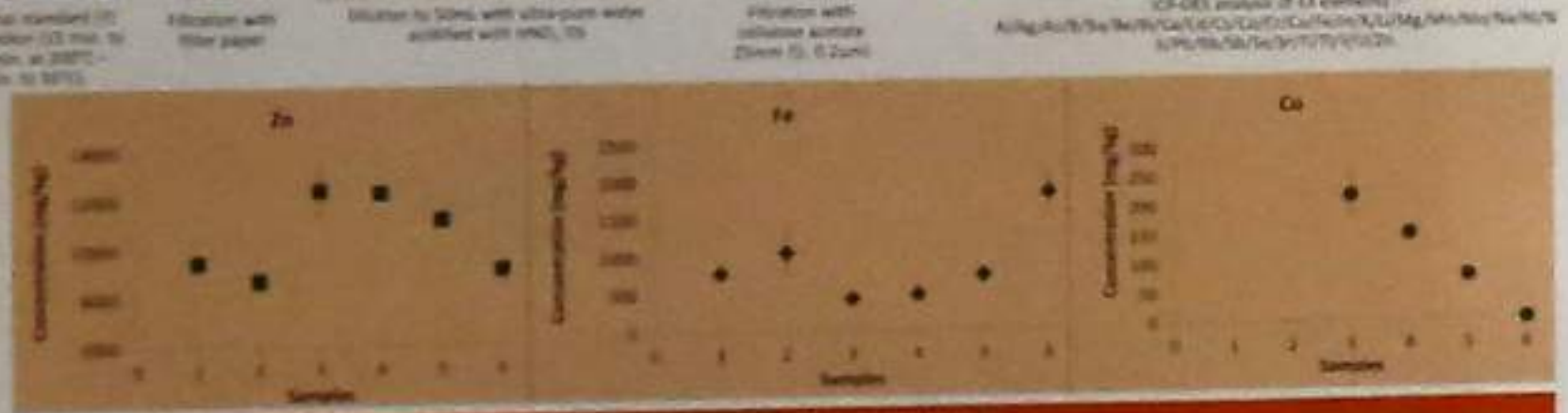
For this reason, it is important to perform a complete screening, starting with:

METALS IN CRUMB RUBBER SAMPLES FROM CHILE

Method

Results

Samples	Local	Type of Field
1	Central region of Chile	Full 1 – outdoor
2		Full 2 – outdoor
3		Full 3 – outdoor
4		Full 4 – outdoor
5		Full 5 – outdoor
6		Full 6 – outdoor



The order that describes the concentration of other important elements, namely heavy metals, analyzed in crumb rubber samples are: Co (3.8±0.5 to 59.8±12.2 mg/kg) > Pb (n.d. to 34.0±8.4 mg/kg) > Mn (3.0±0.3 to 17.3±0.6 mg/kg) > Cr (n.d. to 7.1±0.5 mg/kg). As, Ni, Cd were not found in these samples.

Zn in the form of ZnO is an **activator** in the vulcanization process of tire manufacturing;
Fe is one of the three most abundant inorganic compounds in tires probably due to the chemical link between the steel belt and the rubber;
Co is used in the **synthesis of polybutadiene rubber.**[1]

[1] Manoli, J. et al. J Environ Anal Toxicol 5 (2014) 1 doi: 10.4172/2161-0525.1000292

CONCLUSIONS

Crumb rubber from ELT used in synthetic turf football pitches include numerous toxic and potentially carcinogenic compounds. The levels of metals obtained in samples from pitches located in the Central region of Chile are in line with those reported in literature. Significative differences were observed between different fields being field 3 and 4 quite similar. **Project SAFEGOAL** intends to evaluate the risks and enforce a safer use of crumb rubber.

ACKNOWLEDGEMENTS