

## **Rubber – its implications to Environmental Health – a survey**

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The UK Sports and Play Construction Association (SAPCA) has convened a Working Group to investigate environmental and health concerns over the use of crumb rubber in artificial sports surfaces, and this paper covers one recent input to this Group. This input is an evaluation current findings in the light of our understanding of the nature and behaviour of rubber.

Rubber is a term applied to class of materials. Rubber is not a single chemical type, and a variety of different rubbers are encountered in everyday life. For example, the rubbers in granulate for artificial sports surfaces are found amongst the commodity hydrocarbon rubbers, e.g.: natural, SBR and EPDM. Quite possibly the different types may not be readily distinguishable from one another – but, even to the untrained observer, they will probably be immediately recognisable as rubber. Resilience and large-strain elasticity usually make for instant recognition.

The unique characteristics of a rubber arise from a unique molecular structure. This paper will consider the nature of rubber, and pay due attention to its molecular make-up from the perspectives of:

- the ingredients from which it is created
- the species it has the potential to release

and make the point that the two are not necessarily the same.

This paper will explain how this unique structure is the result of a chemical process (vulcanisation) and how the chemistry can consume and create species. It will explain how this molecular structure provides a particularly favourable matrix for the retention of some organic species – even to the extent that chemicals can be taken up into the rubber from its surroundings. By giving provenance to the various species encountered in studies of releases from rubber, it will provide a basis for understanding the release patterns observed.

A wealth of data has been published on the health and environmental risks from rubber. This paper will consider these findings in relation to specific concerns over:

- polycyclic aromatic hydrocarbons (PAHs)
- benzene
- phthalates
- alkylphenols
- heavy metals

in respect of exposures by releases to air or to water, or in skin contact scenarios.

In examining these findings, it will prove important to make the distinction between species which are the ingredients or by-products of manufacture, and those which result from uptake in service. In this context, virgin and used rubbers can present different release profiles. Thus the rubber type is not the only distinguishing variable, its history is also a factor. Whilst the latter can introduce an element of variability into a granulate, there are huge benefits to be gained by responsible reuse of scrap-tyre rubber.

Benzene, the PAHs and zinc compounds are all encountered in virgin tyre rubber, whilst zinc is also a common component of many other rubbers. Additionally, all are widespread in the environment from other sources. The phthalates and alkylphenols are not tyre ingredients, but are common environmental pollutants which can be absorbed into tyres in service.

That species of concern are amongst those preferentially retained by rubber is an important factor in the limitation of exposure risks. Furthermore, any risks to health from tyre or other rubbers must be put into context of the risks from daily life. In this context, no additional risks to health are apparent from the research seen to date.

Environmental risks are somewhat different, and it is important to recognise that tyre rubber should not serve as accumulator for environmental toxins (endocrine disruptors) which are then capable of localised release from granulate in sports-surface applications. No doubt this point will need to be addressed in any environmental standards for granulate from reused rubber.

In any environmental assessment, the required testing should only address realistic release scenarios, as there are a wide range of species which can remain firmly entrapped within the rubber under normal contact situations. Thermodynamic compatibility is a critical factor here, and those molecules of more limited affinity to rubber may face a form of molecular expulsion. This is another consequence of the unique molecular structure of rubber - in effect species of limited affinity can be "squeezed out" of the rubber and create a surface "bloom".

The common hydrocarbon rubbers are inherently hydrophobic, but the blooming of water-soluble species presents a mechanism for aqueous leaching. Zinc salts have a potential to bloom in rubber, and water of low pH can effect their subsequent removal from the rubber surface. This results in the possibility of an adverse localised environmental impact. No doubt, leachable zinc levels should figure in any environmental standards for rubber granulate.

Of course, a comprehensive risk assessment should also take account of the likely benefits. Few products can attack the scrap tyre mountain as effectively as these rubber granulates. On this basis, the environmental impact may be positive, whilst the risks to health appear negligible.

This assessment is now under review by the Working Group of SAPCA. A full report, with recommendations, will be issued in due course.

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### **Dr Bryan Willoughby**

Bryan Willoughby holds qualifications in polymer chemistry (PhD, BSc, CChem, FRSC), in materials science (FIMMM) and in occupational hygiene [MFOH(S)]. He was employed at Rapra (the UK-based Rubber and Plastics Consultancy) for thirty years, and set up his own independent consultancy in 2002.

During 1973-75, Bryan was involved in monitoring PAHs in workplace atmospheres in UK tyre companies, and proposed the method for workplace fume surveillance

subsequently adopted by the BRMA (1978) and UK HSE (1988). Since that time he has monitored workplace air and emissions at rubber companies in the UK, mainland Europe and in the USA. He has researched ingredient-emission relationships for rubber, from both technical and environmental perspectives, and published widely on the findings obtained.

Bryan is a member of the Standards for Artificial Turf Working Group of the Sports and Play Construction Association (SAPCA). SAPCA is working with the British Standards Institute (BSI) to help to prepare a new European (CEN) Standard for artificial sports surfaces.