GEZOLAN

TECHNICAL PAPER

The Difference between polymer content and EPDM content

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Brief overview

Several factors are decisive in determining the quality of an EPDM granule used to make sports and leisure surfaces. This technical paper explains one of the most important factors: EPDM content. In addition, the important difference between EPDM content and polymer content is explicitly discussed and the question why this distinction is relevant is answered.

Introduction

EPDM granules used for sports and leisure surfaces consist of various ingredients. EPDM, a synthetic rubber, forms the basic raw material. Together with the other ingredients (e.g. filler, oil, color pigments), this becomes a so-called (EPDM) compound material in a mixing process. Due to its ability to crosslink, the raw material EPDM is the ingredient that holds everything together in an EPDM compound granule. Therefore, among other things, the EPDM content of a granule is relevant for its quality.

For more information on the typical ingredients of EPDM granules and their functions, please refer to the separate Technical Paper "Typical composition of EPDM granules for sports and leisure flooring", which is available on request.

Definition Polymers

Polymers are materials consisting of macromolecules. They can be produced synthetically, but also occur naturally. Synthetic polymers are the main component for the production of plastics. Based on their physical properties, polymers are divided into thermoplastics, elastomers (rubber) and thermosets. Known thermoplastics are, for example, polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) and polystyrene (PS; better known in a foamed form under the brand name Styropor®).

Definition EPDM

Ethylene propylene diene rubber (EPDM) is one of the most important synthetic rubbers. EPDM belongs to the group of elastomers and is therefore a polymer. EPDM can be vulcanized by wide-mesh crosslinking to form a rubber-elastic material.

Difference between EPDM content and polymer content in rubber granules

During the production of EPDM granules, the so-called vulcanization creates a three-dimensional cross-linking of the long, chain-like molecular building blocks of the polymer used and the raw material rubber ("caoutchouc") becomes the resistant and elastic material rubber. It is only through this cross-linking that a resistant and stable product is obtained. Assuming all other factors to be equal, the following applies: "The better the crosslinking properties of the polymer(s) used, the more stable the final product!" The polymer used is therefore the decisive factor for optimal crosslinking and thus for a stable, resistant end product.

In the sports flooring industry, the polymer content of an EPDM compound granule is often considered an important key performance indicator of its quality. However, it is important not to equate EPDM and

polymer and not to confuse polymer content with EPDM content. EPDM is a comparatively expensive but also high-quality polymer with good crosslinking properties. However, there are also polymers that have less good crosslinking properties and are therefore less expensive. EPDM is therefore not the only polymer, but rather one of many.

Determination of polymer content in rubber granules

A common analytical method for determining the ingredients in polymer compounds, such as rubber granules, is the so-called thermogravimetric analysis (TGA). In this method, a small sample of material is placed on a highly sensitive balance in an oven and the decomposition temperatures of the ingredient groups are recorded at a constantly increasing temperature curve (up to 1,000 °C / approx. 1,800 °F). Different decomposition stages can be determined via the respective decomposition temperature and the ingredients can be identified as a substance group. The height of the respective stage correlates with the quantitative proportion of the substance group in the compound.

1. At elastic sports floor granules, the **first stage** indicates the proportion of short-chain hydrocarbons (mainly plasticizer oil, waxes, partly impurities). It is typically at 250-300 °C (~ 482-572 °F).
2. The **second stage** corresponds to the polymer content. Important: A TGA cannot tell which polymer(s) are involved!
3. Mineral fillers do not decompose in a TGA or only in combination with oxygen. Therefore, they usually form the residue.

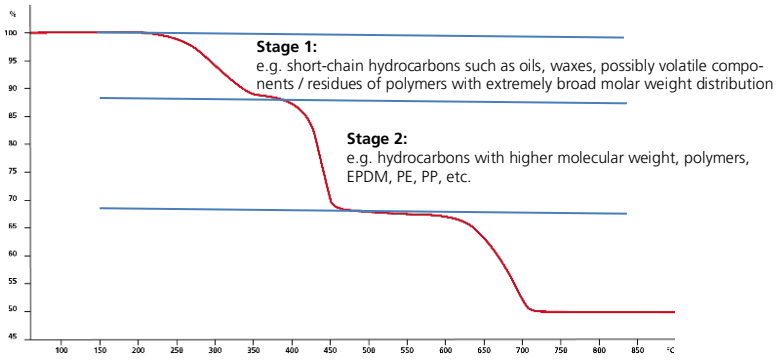

Figure 1: Exemplarily graph of a TGA

Important (!)

The qualitative composition of the material should be known, since a TGA is a solely quantitative measurement method and substances with the same decomposition temperature cannot be distinguished in the TGA (e.g. different polymers). The result of a TGA therefore says nothing about the actual ingredient used and its quality, but merely indicates the percentage of the total group of substances in the material sample to which an ingredient belongs. In the case of rubber granules, for example, a TGA can be used to determine the polymer content, but not to determine which polymer is actually involved.

Since a TGA only measures the total proportion of all polymers contained, but does not say which polymers are contained, a well-crosslinkable EPDM cannot be distinguished analytically from another polymer that is poorly crosslinkable. It is therefore not possible to measure the EPDM content, but only to determine the content of all polymers contained. A high-quality EPDM can therefore be replaced by lower-cost polymers with inferior properties without negatively affecting the polymer content.

Figure 2 illustrates exemplary how different the composition of the polymer content can be in a granule for sports and leisure surfaces, despite identical results in the TGA. The polymer content is identical in all three scenarios and is 20% as an example. In particular, the degree of crosslinking differs greatly in the three given scenarios, since only EPDM offers the necessary crosslinking options (e.g. with sulfur).

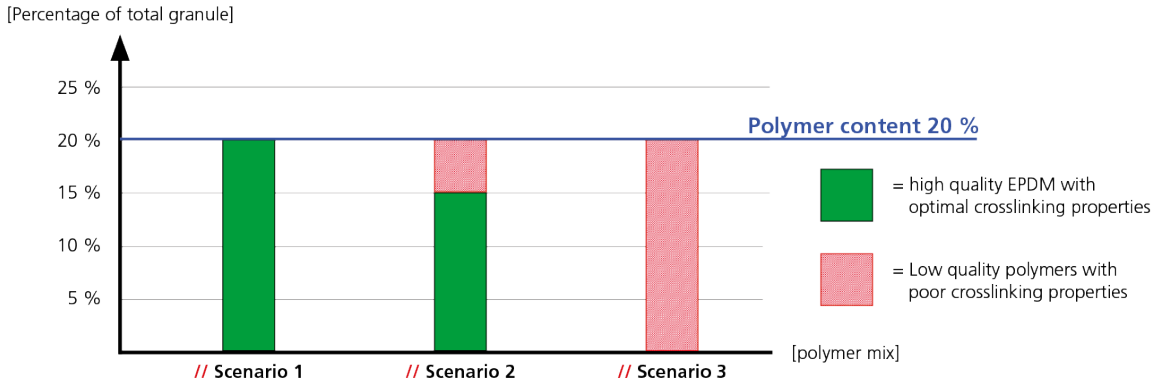

Figure 2: Example of three polymer compounds. The polymer content measured via TGA is identical for all three scenarios, and the products cannot be distinguished via TGA.

In theory, this means an identical polymer content, but other polymers than EPDM result in reduced cross-linking. In the case of low-grade EPDM granules, for example, the high-quality raw material EPDM is often saved by partially substituting it with other, lower-quality polymers. This is critical, as crosslinking gives the sports floor granules their most important properties – elasticity, durability and UV stability. Therefore, only high-quality EPDM should be used as the polymer. The quality characteristic of EPDM granules used in sports and leisure surfaces is therefore not the polymer content, but only the EPDM content! Relying solely on a manufacturer's polymer content statement is not sufficient. Rather, critical questions should be asked: Which polymers were used? What is the percentage of each polymer that was used?

The optimum EPDM content

EPDM is the "rubber component" in an EPDM granule and thus, simply put, the property-determining and qualitatively decisive raw material. EPDM holds everything together in the compound and provides a stable and resistant granule. However, the saying "the more, the better" does not apply here. Rather, over 50 years of experience has shown that an EPDM content of 20% is the best compromise between cost and quality, offering the best balance between price and important properties such as elasticity, UV stability and durability. An EPDM content above 20% does not guarantee better properties of the final product. Only the balanced mixture with the other ingredients ensures an EPDM compound granule that is optimally matched to the requirements of the intended application. With a higher EPDM content, the end product would possibly lack crucial properties for the intended end use or be negatively affected. In addition, a higher EPDM content does not provide any additional benefit that would justify the extra cost and is therefore not economical.

An EPDM content of 20% is thus the first indicator of a high-quality EPDM granule. However, know-how about the best possible composition and processing of raw materials is just as crucial.

Lessons learned

- EPDM is one of the so-called polymers.
- EPDM is not the only polymer, but rather one of many.
- EPDM is a high-quality polymer with good crosslinking properties.
- In addition to EPDM, there are polymers with poorer crosslinking properties.
- Good crosslinking properties are crucial for stable and resistant EPDM granules.
- The individual groups of substances contained in an EPDM granule can be determined proportionally by means of thermographic analysis (TGA). However, the ingredient actually used and its quality is not!
- Polymer content ≠ EPDM content: The polymer content of rubber granules can be determined by means of a TGA; however, it cannot be determined which polymer it is or whether it is EPDM.
- It is not possible to measure the EPDM content, but only to determine the content of all polymers contained.
- A high-quality EPDM can therefore be replaced by lower-cost polymers with inferior properties without negatively affecting the polymer content.
- The quality characteristic is not the polymer content of a rubber granule, but only its EPDM content!
- The optimal EPDM content for an EPDM granule for sports and leisure flooring is 20%.
- A high-quality raw material EPDM has its price, which must be reflected in the end product EPDM granule (you cannot have both "good and cheap"!)

Index of relevant terms

EPDM	Short for ethylene propylene diene rubber; one of the most important synthetic rubbers, belongs to the polymers group of substances
EPDM (Compound) granules	Rubber granules comprising several ingredients with EPDM as the base material; commonly referred to as EPDM granules
Polymer	Materials consisting of macromolecules; can be produced synthetically, but also occur naturally. Synthetic polymers are the main component for the production of plastics.
Thermogravimetric analysis (TGA)	Thermal analysis method in which the change in mass of a material sample is determined as a function of temperature, time and the surrounding atmosphere in order to determine the substance groups contained and their percentage in a material.
Vulcanization	Process in which raw material rubber ("caoutchouc") is made durable by means of pressure and heat. The end product of vulcanization is rubber.