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WHITE PAPER

HELPING INDUSTRY VALUE CHAINS REDUCE THE CARBON FOOTPRINT USING THERMOPLASTIC VULCANIZATES (TPV)

A CELANESE SUSTAINABLE SOLUTION

Thermoplastic vulcanizates (TPVs) that include post-consumer recyclate (PCR) can contribute to carbon footprint reductions

BY OLIVER KLOTH, SUSTAINABILITY LEADER

The materials being used in manufacturing and their impact on the environment is very much a driving force for reduce, reuse and recycle. Initiatives like the European Green Deal and the US Inflation Reduction Act are stimulating value chains to constantly consider how new sustainability objectives can be achieved.

As a result, value chains are looking to achieve sustainability benefits in several ways, including: using less material; reducing energy consumption through light-weighting or during manufacturing; lowering carbon dioxide emissions; simplifying manufacturing processes that use less parts; recycling of scrap producing during manufacturing; or, recycling parts at end-of-life and incorporating that recycled material into new polymers and parts. The ultimate goal being to deliver sustainable solutions that reduce environmental footprint while being safe to use.

TPV – a 40-year legacy of sustainability benefits

The rubber industry is very much in its infancy with regards to the development of solutions with sustainability benefits. While rubber can deliver outstanding performance, three of the major issues it faces when it comes to delivering sustainability benefits are that it is often heavier than alternative materials, more complex to use in manufacturing and can be more difficult to recycle.

While the rubber industry in general is finding it tough going in meeting society's sustainability demands, there is one stand-out type of elastomer that has been delivering sustainability benefits since it was introduced 40 years ago. Thermoplastic vulcanizates (TPV) are a ready to use material that deliver performance like rubber but can be processed like a thermoplastic.

TPVs enable the rubber industry to deliver sustainability benefits in several different ways:

- Reduce carbon footprint by up to 59% versus EPDM in automotive glass run channels.
- TPVs do not need curing so energy consumption can be reduced by up to 50% versus EPDM part production.
- Scrap produced during processing can be recycled.
- Once the use phase of a part is over, industry and society will have to recover valuable raw materials. Recycling schemes are not ready yet, but data from Celanese tests of regrind material are a clear indicator that Santoprene® TPV would be a good candidate for potential future mechanical recycling systems.
- Compared to the thermoset rubbers (TSRs) they often replace, they can reduce part weight to up to 50% in automotive glass run channels as they are less dense, enable part redesign, and allow metal reinforcement parts to be eliminated.

All while reducing total system costs.

TPVs which include recycled content are now possible

Considering the performance and sustainability opportunities offered by TPVs, the value chain is increasingly switching from thermoset rubbers, like EPDM, to TPVs. Demand would accelerate even faster if TPVs could be produced that included recycled content. Well now they are.

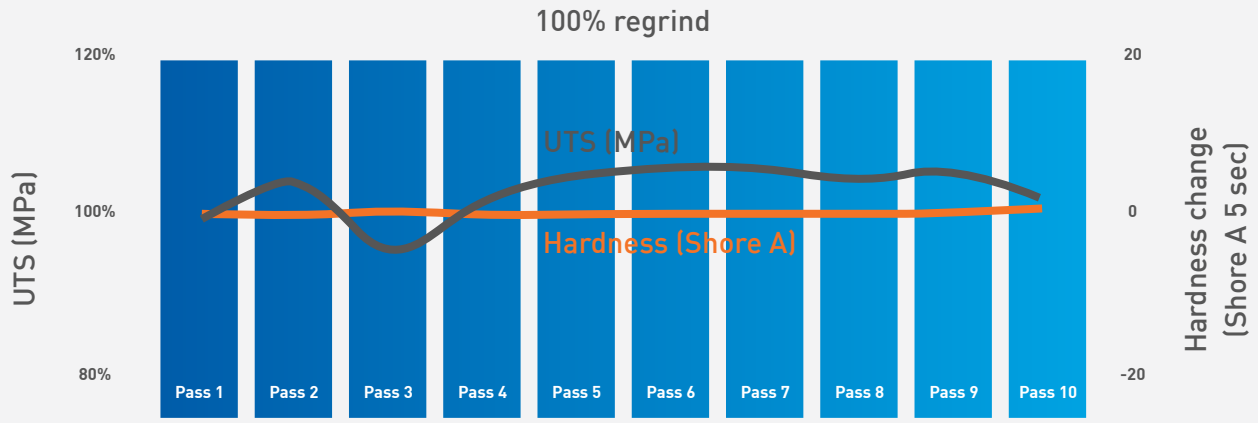
Celanese Corporation has recently introduced two Santoprene® TPV ECO-R grades that include 15% and 25% post-consumer recycle (PCR). These are the first of a new platform that will include more grades with recycled feedstock. With a legacy of delivering opportunities for sustainability benefits since it was first introduced 40 years ago, Santoprene® TPV, the acknowledged industry-leading brand, continues to set the benchmark for TPVs.

Developing a circular economy with Santoprene® TPV ECO-R

Santoprene® TPV 101-80 ECO-R incorporates 15% PCR and Santoprene® TPV 101-87 ECO-R 25% PCR, both designed for injection molding and extrusion. While these grades target various potential applications, they are also the entry point to the new platform. Additional programs are looking at hardness, processing options and colorability. But what about the property retention of TPV that includes PCR?

Santoprene® TPV 101-80 ECO-R was taken into a regrind study with 100% regrind. Plaques were molded using 100% regrind with 10 passes of regrinding and molding. The results are impressive with very little changes in ultimate tensile strength or hardness, often within the sensitivity of the test. This data illustrates how easy it is to use Santoprene® TPV grades that contain PCR as property retention, even after 10 passes is outstanding.

Santoprene® TPV 101-80 ECO-R property retention



Graph 1: Santoprene® TPV 101-80 ECO-R: Lot# PXG5958 test conducted with 100% regrind material; properties measured on injection molded plaque.

CO_2 footprint reduction with Santoprene® TPV

Based on deep product and process understanding, carbon footprint values have been estimated for extruded profiles produced both with Santoprene® TPV and with industry standard EPDM rubber compounds.

By doing so, the main drivers for potential carbon footprint reductions with Santoprene® TPV versus parts produced with EPDM rubber were identified.

Standard grades of Santoprene® TPV have a density of 0.97. EPDM compounds with similar properties have densities in the range of 1.2-1.3 kg/l. This means a similar part can use up to 30% less TPV than EPDM rubber.

Another major difference is in the processing. EPDM rubber parts need to be cured before use, a process which is very energy and carbon intensive.

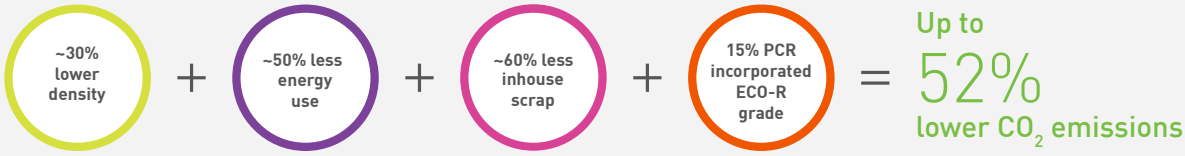
A third point is scrap reduction via regrinding. Depending on the part design and material combination, up to 30% less scrap is produced versus EPDM part production. Lower density, less processing energy and less scrap can add up to 38% carbon footprint reduction potential versus EPDM part production.

With the new Santoprene® ECO-R grade, there is an even higher carbon footprint reduction potential. Processors using the Santoprene® TPV 101-87 ECO-R grade, can achieve carbon footprint reductions of up to 59% versus EPDM.

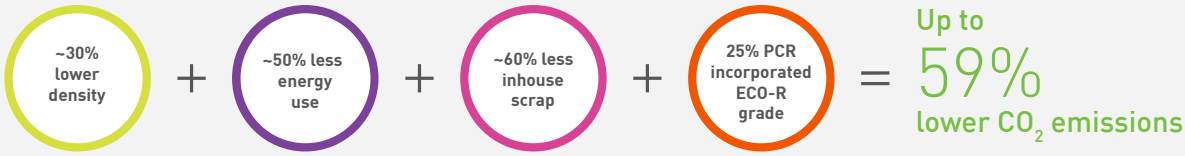
Calculated CO_2 footprint reduction | Santoprene® TPV vs. EPDM

Santoprene® TPV standard grades

Santoprene® TPV 101-80 ECO-R grade



Santoprene® TPV 101-87 ECO-R grade



Graph 2: Calculated carbon footprint results are based predominantly on industry average carbon footprint values and may not contain Celanese primary data.

Values provided herein are general estimates based on approximate reference values for specific materials and processes. Values are intended for use as part of high-level screening only and should not be construed as exact measurements of CO_2 or other values for specific products. The contents of this document may be updated or modified by Celanese at any time.

Ecodesign for additional sustainability opportunities

In March of 2022, the European Commission made a proposal for an Ecodesign Directive which includes minimum requirements for products sold and produced in the European Union. Ecodesign requirements would aim to improve product durability, reliability, reusability, upgradability, reparability, possibility of maintenance and refurbishment, presence of substances of concern, energy use and energy efficiency, resource use or resource efficiency, recycled content, possibility of remanufacturing and recycling, possibility of recovery of materials, environmental impacts and expected generation of waste materials. To get there, five leading principles were established.

1. Reduce: That includes reducing raw materials, waste, weight, production complexity and energy. In the picture below are examples where Santoprene® TPV is meeting all these requirements. It is a complex part of an industrial hose that consists of four different components made from different materials. In this multi-material combination, all parts and materials serve different functions. All these functions were combined into one single part made from Santoprene® TPV.

Ecodesign with Santoprene® TPV

From:
multiple parts

To:
one part
(no assembly)

2. Re-use: Santoprene® TPV 101-80 ECO-R incorporating 15% PCR and Santoprene® TPV 101-87 ECO-R 25% PCR are great examples of material reuse. The grades are just the first of a new Santoprene® TPV ECO-R platform of products that contain PCR.
3. Repair: This is something that will have a major impact in terms of how many spare parts producers and OEMs will have to keep in stock over the lifetime of their products. With Santoprene® TPV, you can design parts for thermoplastic processing which enables customers to realize different geometries versus thermoset rubber. Less complex processing should make spare part production much easier.
4. Recover: Once the use phase of a part is over, industry and society will have to recover precious raw materials. Recycling schemes and programs are not advanced enough yet to deal with all that this principle entails, but studies using internal regrind clearly indicate that Santoprene® TPV can be suitable for mechanical recycling systems.
5. Dispose: Touches all of society and is not unique to a single material. Correct disposal means making sure that products can be safely disposed of without harm to the environment, today or in the future.

While these Ecodesign principles are not yet final, the likelihood of more regulation as part of the Extended Producer Responsibility (EPR) strategy is high.

Continuing to create carbon reduction opportunities

Having helped the industry create more sustainable products for 40 years, Santoprene® TPV now provides additional sustainability benefits with a new Santoprene® TPV ECO-R platform that incorporates PCR. It is clearly the solution of choice to help the rubber/elastomer industry achieve significant carbon footprint reductions.

Plus, as an industry-leading provider of engineered materials and specialty polymers, it is acknowledged that Celanese is committed to helping the industry achieve carbon footprint reductions.
As part of that commitment the Hytrel® thermoplastic elastomers (TPEs) portfolio was recently acquired. Within the portfolio, Hytrel® TPC-ET ECO-B elastomer uses up to 72% second generation bio-based feedstock (mass balance), enable over-molding on rigid thermoplastics, and allow rework and recycling of scrap. As a result, there is a broader portfolio of sustainable material options from one committed supplier.

Achieving sustainability and circularity along the value chain undoubtedly, however, requires collaboration from raw material choice, through part design and processing to final product.
So, let's start working together to help make a better world.

DISCOVER MORE ABOUT SANTOPRENE® TPV ECO-R

Contact us for more information:
www.santoprene.com

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