GLOBAL OUTLOOK

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ROAD SURFACE TECHNOLOGY

ANALYSING THE LATEST TECHNOLOGY, PRODUCTS & SERVICES

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An asphalt mix based upon a PGXpand PMB

CARBON REDUCTION WITH PGXPAND

Sripath's polymeric additive can help reduce the carbon footprint associated with the production of polymer modified bitumen (PMB). Deepak Madan and Jill McConaghie explain.

The call for net-zero emissions is reverberating globally in response to an increasing desire for a circular economy. According to the United Nations, 107 countries, accounting for 82% of greenhouse gas (GHG) emissions, have adopted net-zero goals[1]. However, it appears that efforts to reduce GHG emissions are failing to meet reduction targets set for 2050.

As a result, industries and jurisdictions around the globe are embracing innovative processes and technologies to help meet their sustainability goals. Notably, the asphalt-paving industry is taking steps to meet new GHG emissions standards and to reduce its overall energy consumption.

For example, the UK has adopted a robust set of net-zero goals to reduce carbon emissions during production and paving of asphalt mixes and is evaluating various additives and technologies to reduce GHG emissions[2]. It is well recognised that the majority of energy attributed to asphalt-mix production comes from heating aggregates to the desired production and paving temperatures[3].

As a producer of asphalt additives, Sripath Technologies provides a range of sustainable products that help contractors adopt and implement new technologies. These can help reduce carbon emissions by eliminating excess material use, lowering energy consumption and reducing GHG emissions from 'cradle to gate'. The term refers to a lifecycle-assessment approach that evaluates the environmental impact of a product from its initial extraction of raw materials ('cradle') up to the point where it leaves the manufacturing facility ('gate'). This assessment includes the energy and resources consumed during production which is crucial for understanding a product's overall sustainability before it reaches the consumer.

PMB AND SUSTAINABILITY

Polymer modified bitumen binders are routinely used in road-construction projects due to their enhanced roadway performance. Incorporating polymers into the binder can significantly improve resistance to rutting, cracking and ageing, thus helping to extend pavement life and reducing the need for maintenance. This durability makes PMB especially valuable in regions facing extreme weather or high traffic volumes.

While these benefits clearly bolster cost savings, PMB use can also help contractors pursue their sustainability goals. The longer service life of PMB-based roadways can mean fewer repairs and resurfacing cycles. This can directly reduce energy use, raw-material consumption and greenhouse gas emissions over the lifespan of the road. Additionally, PMB-based mixes are also compatible with reclaimed asphalt pavement (RAP), helping reduce the carbon footprint. Furthermore, most polymers used for PMB production are considered to be environmentally stable and inert once blended into bitumen. They typically do not leach harmful substances under normal road conditions.

However, PMBs formulated with styrene-butadiene-styrene (SBS) do pose certain environmental challenges. The production of SBS - a synthetic polymer derived from petroleum - involves energy-intensive processes, resulting in a relatively high value of global warming potential (GWP). Also, SBS-based PMBs typically require high-energy shear mixing, longer mixing times and higher mixing temperatures during production. All this results in higher energy consumption and an increased carbon footprint.

Innovative additives, such as Sripath's PGXpand, are designed to deliver the desired performance characteristics of a PMB

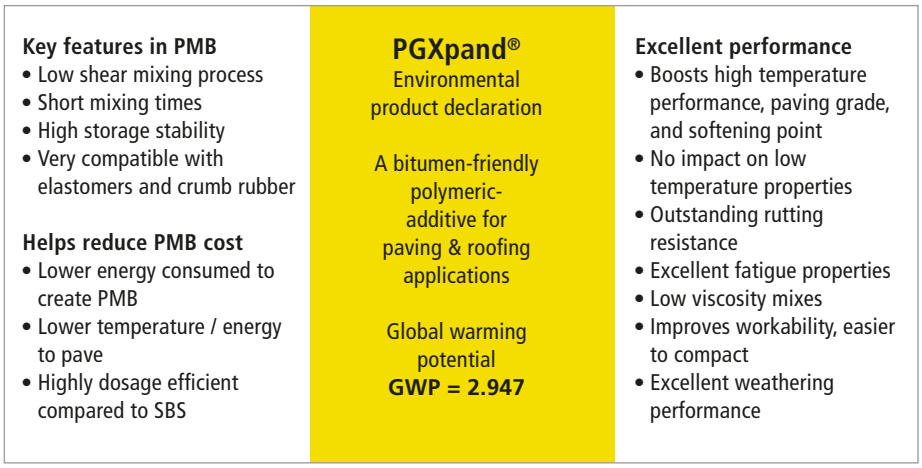

Figure 1: PGXpand: a bitumen-friendly polymeric additive

Traditional elastomeric polymers	PGXpand® bitumen-friendly polymeric additive	Traditional plastomeric polymers
Fatigue: Good Rutting: Acceptable Elastic recovery: Good	Fatigue: Good Rutting: Excellent Elastic recovery: Poor	Fatigue: Poor Rutting: Good Elastic recovery: Poor
Mixer: High shear Mixing time: Long	Mixer: Low shear Mixing time: Short	Mixer: Medium Mixing time: Medium
Mix temperature: High Paving temperature: High	Mix temperature: Low Paving temperature: Low	Mix temperature: High Paving temperature: High
Crosslink additive: Needed Warm mix additive: Needed	Crosslink additive: Not needed Warm mix additive: Not needed	Crosslink additive: Not needed Warm mix additive: Needed

Figure 2: PGXpand differs from traditional elastomeric and plastomeric polymers

→ binder while mitigating the negative impact on sustainability exhibited by traditional polymers.

BITUMEN-FRIENDLY ADDITIVE

Sripath's PGXpand was formulated to optimise PMB production while delivering the desired performance, cost reductions and sustainability results. As seen in figure 1, PGXpand boosts the high-temperature performance, paving grade and softening point of PMB mixes without impacting low-temperature properties. The result is outstanding rutting resistance and excellent fatigue properties for longer lasting road surfaces.

PGXpand-based PMBs are used for a range of paving applications including hot mix, hybrid PMBs, hot-spray seal, high-stiffness asphalt mixes and repair and maintenance jobs. As seen in the PGXpand Environmental Product Declaration[4] (EPD), PGXpand has a global warming potential (GWP) of 2.95kgCO_2eq per kg of PGXpand. As a comparison, the GWP value for commercially available SBS polymers is reportedly around 4.5kgCO_2eq per kg of polymer.

As seen in figure 2, compared to traditional elastomeric and plastomeric polymers, PGXpand has been designed to easily blend into bitumen using low shear mixing equipment, shorter mixing times and lower mixing temperatures. This results in less energy consumed to create a PGXpand-based PMB. In addition, asphalt mixes based on a PGXpand PMB can be paved at lower temperatures.

PGXpand is a highly dosage-efficient additive when compared to traditional polymers. Also, when using PGXpand, there is no need for a crosslinking additive or a warm-mix additive. The reduction or elimination of raw material helps further reduce the carbon footprint.

PGXPAND AND GLOBAL WARMING

As part of this study, a comprehensive model was developed to study the impact of varying PGXpand content versus SBS polymer content on the global warming potential. Table 1 lists the key parameters and assumptions adopted for this study.

Because PGXpand is a highly dosage-efficient additive, typically only 3% of PGXpand is needed to deliver the same performance as a PMB with 6% SBS. Similarly, only 2% of PGXpand is needed to deliver the performance of a PMB with 4% SBS.

In figure 3, GWP values are reported as kgCO_2eq per tonne of PMB. A PMB with 3% PGXpand had a significantly lower GWP value - only 93kgCO_2eq per tonne - compared to a GWP value of 41kgCO_2eq per tonne for a PMB with 6% SBS. Furthermore, a PMB with 2% PGXpand has a GWP value of 64kgCO_2eq per tonne.

Figure 4 depicts the percentage reduction in GWP for various PMBs compared to the control PMB produced with 6% SBS. Increasing PGXpand content while lowering SBS results in higher values of percentage reduction in GWP.

PMB "A", with 4.5% SBS and 1.25% PGXpand, shows a percentage GWP reduction of 19%. Meanwhile, PMB "B", with 3.5% SBS + 1.25% PGXpand, shows a percentage GWP reduction of 30%.

Thus, replacing SBS with PGXpand can reduce the overall carbon emissions while delivering comparable mix-level performance.

PMB "C" with 3% PGXpand shows a percentage GWP reduction of 77%. PMB "D" with 2% PGXpand shows a percentage GWP reduction of 85%. This suggests that while PGXpand-based PMBs can deliver performance comparable to the control PMB, they are a much more sustainable alternative to SBS when considering lifecycle emissions.

As part of this study, the percentage reduction in GWP was also evaluated for PMBs produced using a crosslinking additive. Figure 5 illustrates that even when a crosslinking additive is used during the production of the PMB, replacing SBS with PGXpand improves the carbon savings. Compared to the control, with 4% SBS, both the PMB with PGXpand addition showed a higher value of percentage GWP reduction. The data suggests that reducing

Polymer	Content	GWP, kgCO_2eq per kg polymer	Mixer type	Mix time	Crosslinker
SBS	0-6%	4.5	High kw	Long	Yes
Hybrid	Both	Based on %	High kw	Long	Yes
PGXpand	0-3%	2.95	Low kw	Short	No

Table 1: Key parameters and assumptions

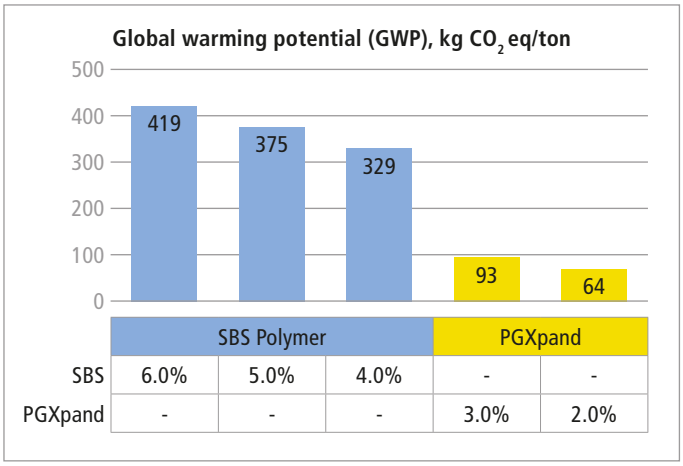

Figure 3. Impact of varying SBS polymer and PGXpand content on GWP

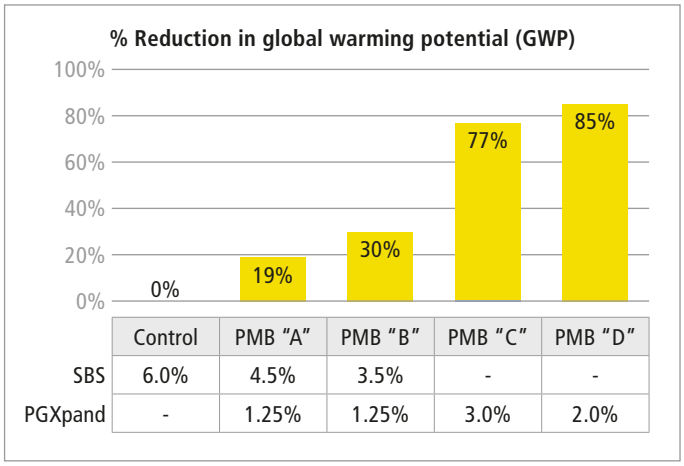

Figure 4. Impact of PGXpand on percent reduction of the global warming potential

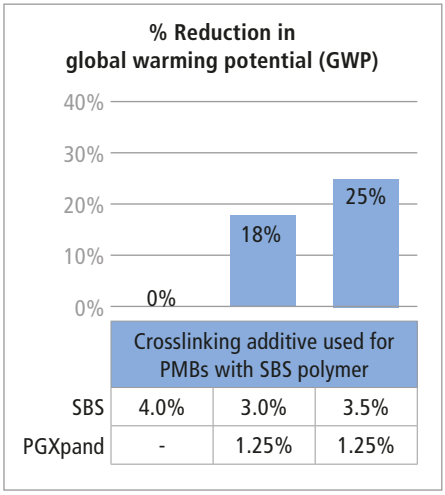

Figure 5. Impact of PGXpand on percent reduction of the GWP potential of crosslinked PMBs

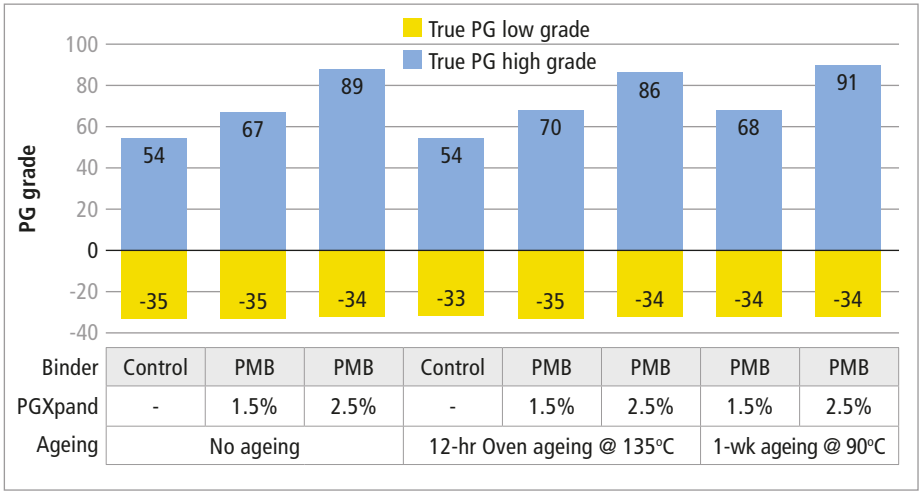

Figure 6: Ageing performance of PGXpand in a polymer modified bitumen

SBS while increasing PGXpand, even in the presence of a crosslinking additive, can lead to a reduction in carbon emissions while delivering the desired mix-level properties.

PGXpand offers a more energy-efficient approach to producing PMB, helping producers lower energy consumption and production costs. The additive is engineered to reduce greenhouse gas emissions throughout its lifecycle including production, transportation and during use in the intended application. PGXpand also enables paving and compaction at reduced temperatures, leading to additional savings in fuel and operational costs.

Figure 6 shows that PGXpand-based PMBs maintain the true PG low grade even after various ageing regimens, demonstrating these PMBs have good resistance to ageing and can deliver long-term surface durability.

CONCLUSION

As an example of a real-world case (see main image of article), a road surface was paved using a PMB binder dosed with 1.5% PGXpand. A 30mm wear layer was paved on a one-kilometre four-lane section of the heavily used highway. Paving was done at a temperature of 130°C compared to 160°C for a control mix. The PGXpand-based PMB was easy to produce, had superior mix properties and workability and delivered excellent rutting resistance.

Sripath has a strong track record of committing to sustainability. The company has embraced transparency by making all its Environmental Product Declarations easily accessible online[4]. The EPDs are issued by the Environmental Footprint Institute, Madrid, Spain.

With a GWP of 2.95kg of CO_2eq per kg of PGXpand, the bitumen-friendly polymeric additive exhibits lower greenhouse gas emissions than traditional polymers used in PMB production. ■

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Sripath Technologies is a global company that develops, manufactures and markets bitumen and asphalt additives, all with an emphasis on sustainability. Deepak Madan, chief operating officer of Sripath, received his PhD from Rensselaer Polytechnic Institute in the US city of Troy in New York state.

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