



General Sustainability information about RheoFalt HP-AM

Environmental profile:

RheoFalt HP-HP-AM is a completely natural product that is made from the oil of cashew nutshells. The product (CNSL) is used in the epoxy coating industry and the friction materials industry. Only a small part is used for this, the remainder is used as fuel for power plants or it is dumped. RheoFalt HP-AM is processed from raw CNSL into an aromatic resin with a molecular weight that fits in the maltene fraction of bitumen.

No residue remains after this operation.

RheoFalt HP-AM is listed as a permitted building material on the Dutch Approved Materials for Asphalt Applications (NCOB) list for hot mixes. (based on BRL 9320, environmental effect norms)

Life Cycle Analysis:

RheoFalt HP-AM ensures that aged bitumen with an increased asphaltene content (polar effect of asphaltene over time) is again improved to new value. RheoFalt HP-AM does not do this by reducing the content of asphaltene, but by isolating the polar effect. This makes both aged bitumen 100% reusable, as well as the current bitumen (which contain higher asphaltene contents by cracking and hydrogenating) can be used without disturbing the colloidal equilibrium. RheoFalt PB is a mix of RheoFalt HP-AM and a maltene resin for the use of bitumen for polymer additives. This actually reduces the asphaltene content and increases the maltene content, which is needed to dissolve polymers.

In Life Cycle Analyse calculations, one looks at the life cycle of a product from raw material extraction to the disposal phase after use. Because RheoFalt HP-AM makes it possible to reuse old asphalt multiple life cycles, each time again and for 100%, the LCA is, as it were, infinite.

An average Environmental Cost Indexing value, calculated according to the Dutch ECO CHAIN principles, provides an ECI value of 4.51 € for 50% recycling. The calculation on 100% recycling with the use of RheoFalt HP-AM (0.3% addition) shows an ECI of 2.83 €.

The impact on the ECI of RheoFalt HP-AM as product amounts to -0.12 € per 0.1% addition per ton of asphalt. The calculated asphalt mix with 100% recycling and 0.3% addition of RheoFalt HP-AM thus has the lowest Environmental Cost Indicator of a range of calculated mixtures with 0-30-50-70 and 100% recycling. See the following table:

| Adding RAP percentage in asphalt | ECI costs |
|----------------------------------|---|
| 0% | €6.56 in 1MT of asphalt produced and processed. |
| 30% | €5.41 |
| 50% | €4.51 |
| 70% | €3.58 |
| 100% (with RheoFalt HP-AM 0.3%) | €2.83 |



Naturally, this depends on the energy consumption per asphalt plant and must be specified by the asphalt plant itself and be recalculated for use .

Figure 1:

CO₂ reduction on raw materials aspects (bleu), processing energy(green) and transportation (red) Total need of energy and used kg of CO₂ shown by reuse of 0% ,30%, 50%, 70% and 100% RAP pro 1mt new asphalt

Figure 2: ECI value based on ECO chain principles





Biobased and circularity:

Because of the origin from the cashew peelings and the non-addition of other products, RheoFalt HP-AM is completely bio-based.

When RheoFalt PB is used for modified bitumina, about half of it is based on bio-based material. The maltene resin is about 50% of the product and is of synthetic origin.

Because of the ability to reduce obsolete bitumen to new value, RheoFalt HP-AM is able to make asphalt completely circular up to 100% reusability without loss of properties.

CO2 profile:

Compared to 50% recycling, the 100% recycling mix with 0.3% RheoFalt HP-AM per MT processed and produced asphalt from 47.41 kg CO2 to 34.06 kg CO2. The contribution of RheoFalt HP-AM has been calculated at 2.71 kg CO2 because of production, storage and dosing. Per 0.1% dosage (depending on the penetration increase requirement) this is 0.9 kg of CO2 consumption per MT of asphalt.

Functionality:

RheoFalt HP-AM increases the penetration whereby, according to the log-pen mix calculation, asphalt mixtures will fall into a better penetration rate at higher PR percentages. It lowers the stiffness of a mixture and increases the resistance to fatigue. (less susceptible to cold fracture).

RheoFalt HP-AM isolates the polar action of asphaltenes, thus extending the life span.

RheoFalt HP-AM improves the phase angle so in 3D elemental calculations less asphalt thickness is needed for constructions.

Because RheoFalt HP-AM effects flexibility, penetration is increased, healing factor, which is dependent on penetration and binder content to increase to the value of 4. Normally there is a bottom layer of 70% or more recycling around the grade 35. With an average of 0.3% RheoFalt HP-AM it can be pushed back to a penetration of 50 and the healing can be set to 4 instead of 2,77.

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