

Asphalting with wood

Road constructors are keen to use more sustainable asphalt. Wageningen is working with them to study the scope for partially replacing oil-based bitumen with lignin, a by-product of the paper industry. This reduces CO₂ emissions.

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It is not often that road construction is described as 'sustainable'. Because of the high temperature at which asphalt is processed, a lot of CO₂ is released during road construction. And bitumen of fossil origin is still needed as a binding agent. For more than eight years now, Wageningen has been involved in research on replacing bitumen with lignin from wood. With a view to testing this bio-asphalt under real outdoor conditions, a number of demonstration roads have been constructed around the Netherlands, the oldest of which dates from 2015 and runs across an industrial estate in Zeeland. 'The road surface is in

good condition, there is no wear and tear, in spite of the heavy traffic there,' says lignin expert Richard Gosselink of Wageningen Food & Biobased Research. Other trial roads are performing well too, such as the cycle path near the WUR campus, where Wageningen researchers are testing different kinds of lignin in various mixtures on three sections of the path. The substance provides an alternative to the fossil binder bitumen, but not all lignin is the same. 'Lignin gives the woody stalks of trees or grass-like biomass their firmness. It is a natural product and its characteristics are heavily dependent on the isolation process,

and are different for each kind of wood,' explains Gosselink. Different lignin variants are compared across the sections of road in the trial.

CO₂ IS STORED

In the classic production of bitumen, large amounts of CO₂ are released, whereas lignin from wood actually captures a lot of CO₂. 'Asphalt can last for up to 15 years and the captured CO₂ stays in the road all that time. And even longer if it's recycled,' says Gosselink. And thanks to the use of the natural additive, the asphalt can be processed at a lower temperature. Lignin-based asphalt



Fractionation of biomass



Separation of lignin and cellulose



Lignin

can be produced at a temperature 40 degrees lower than the 180 degrees at which hot bitumen-based asphalt is normally produced. 'This combination of lignin and the lower processing temperature lead to a CO₂ saving of 20 per cent.'

Yet lignin is not yet being used in asphalt on a large scale. One limiting factor for upscaling its use is that it is in short supply. Lignin is a by-product of pulp and paper production, but because of its high energy value, it is used as a fuel by the factories themselves. 'Whereas lignin's economic value as a binding agent is five times higher than that. But if there is not much demand, lignin will not be extracted on a large scale for use as a raw material. Demand will only go up if lignin starts being used in more applications.'

One of the new applications of lignin is in the processing of panel material. Together with panel material producer Trespa, Wageningen Food & Biobased Research has developed panels in which half of the adhesive phenol is replaced with lignin. These have recently been launched on the market.

REUSING LIGNIN-BASED ASPHALT

To further stimulate the use of lignin in asphalt, at the beginning of 2020 Wageningen started working with 22 parties from the entire production chain in the CHAPLIN programme (Collaboration in aspHalt



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Applications with LigniN). The consortium, which includes research institutes, the national public works agency, small and medium enterprises and large building contractors such as Dura Vermeer, wants to conduct additional research with the aim of being able to upscale the use of lignin in asphalt. Partly thanks to a grant of 1.5 million euros from the Netherlands Enterprise Agency (RVO), trial sections will be laid down along a provincial highway this year. 'This will enable us to collect more data about the usage phase, and get a good impression of the life cycle,' says Gosselink.

'We also want to study how the lignin bio-asphalt can be included in the recycling process. For example, we are going to look at whether a surface layer with lignin in it can be reused as a bottom or middle layer. All these steps are necessary for making lignin mainstream in the asphalt industry.'

NO ADDITIONAL FELLING

The recently revived debate on the use of biomass as a source of heat and electricity creates an opportunity for the industry to extract resources such as lignin from wood, says Gosselink. 'When biomass is burned, the CO₂ in it is immediately released into the atmosphere, along with particulates. Used as a raw material, wood captures this greenhouse gas for a much longer time, and no additional trees need be felled for the lignin production.'

Are there any disadvantages to using the natural adhesive? 'At the moment we can't use more than 50 per cent lignin in the asphalt mix,' says Gosselink. 'Its adhesive power goes down after than because that requires some specific components from bitumen.' He sees it as phase 2.0 of the study to replace bitumen completely. 'It would be fantastic if in future we could get all the asphalt characteristics we need from biobased by-products.' ■

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A mixture of lignin and bitumen

'The road surface is in good condition, there is no wear and tear'



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Bio-asphalt