

High Purity Lignin for Asphalt Applications: Using the Dawn Technology™ Wood Fractionation Process

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Abstract : Avantium is a leading technology development company and a frontrunner in renewable chemistry. Avantium develops disruptive technologies that enable the production of sustainable high value products from renewable materials and actively seek out collaborations and partnerships with like-minded companies and academic institutions globally, to speed up introductions of chemical innovations in the marketplace. In addition, Avantium helps companies to accelerate their catalysis R&D to improve efficiencies and deliver increased sustainability, growth, and profits, by providing proprietary systems and services to this regard. Many chemical building blocks and materials can be produced from biomass, nowadays mainly from 1st generation based carbohydrates, but potential for competition with the human food chain leads brand-owners to look for strategies to transition from 1st to 2nd generation feedstock. The use of non-edible lignocellulosic feedstock is an equally attractive source to produce chemical intermediates and an important part of the solution addressing these global issues (Paris targets). Avantium's Dawn Technology™ separates the glucose, mixed sugars, and lignin available in non-food agricultural and forestry residues such as wood chips, wheat straw, bagasse, empty fruit bunches or corn stover. The resulting very pure lignin is dense in energy and can be used for energy generation. However, such a material might preferably be deployed in higher added value applications. Bitumen, which is fossil based, are mostly used for paving applications. Traditional hot mix asphalt emits large quantities of the GHG's CO₂, CH₄, and N₂O, which is unfavorable for obvious environmental reasons. Another challenge for the bitumen industry is that the petrochemical industry is becoming more and more efficient in breaking down higher chain hydrocarbons to lower chain hydrocarbons with higher added value than bitumen. This has a negative effect on the availability of bitumen. The asphalt market, as well as governments, are looking for alternatives with higher sustainability in terms of GHG emission. The usage of alternative sustainable binders, which can (partly) replace the bitumen, contributes to reduce GHG emissions and at the same time broadens the availability of binders. As lignin is a major component (around 25-30%) of lignocellulosic material, which includes terrestrial plants (e.g., trees, bushes, and grass) and agricultural residues (e.g., empty fruit bunches, corn stover, sugarcane bagasse, straw, etc.), it is globally highly available. The chemical structure shows resemblance with the structure of bitumen and could, therefore, be used as an alternative for bitumen in applications like roofing or asphalt. Applications such as the use of lignin in asphalt need both fundamental research as well as practical proof under relevant use conditions. From a fundamental point of view, rheological aspects, as well as mixing, are key criteria. From a practical point of view, behavior in real road conditions is key (how easy can the asphalt be prepared, how easy can it be applied on the road, what is the durability, etc.). The paper will discuss the fundamentals of the use of lignin as bitumen replacement as well as the status of the different demonstration projects in Europe using lignin as a partial bitumen replacement in asphalts and will especially present the results of using Dawn Technology™ lignin as partial replacement of bitumen.

Keywords : biorefinery, wood fractionation, lignin, asphalt, bitumen, sustainability

Conference Title : ICTPE 2019 : International Conference on Traffic and Pavement Engineering

Conference Location : Bangkok, Thailand

Conference Dates : January 17-18, 2019