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Impact of Fischer-Tropsch Wax on Ethylene Vinyl Acetate/Waste Crumb Rubber Modified Bitumen: An Energy-Sustainability Nexus

Authors : Keith D. Nare, Mohau J. Phiri, James Carson, Chris D. Woolard, Shanganyane P. Hlangothi

Abstract : In an energy-intensive world, minimizing energy consumption is paramount to cost saving and reducing the carbon footprint. Improving mixture procedures utilizing warm mix additive Fischer-Tropsch (FT) wax in ethylene vinyl acetate (EVA) and modified bitumen highlights a greener and sustainable approach to modified bitumen. In this study, the impact of FT wax on optimized EVA/waste crumb rubber modified bitumen is assayed with a maximum loading of 2.5%. The rationale of the FT wax loading is to maintain the original maximum loading of EVA in the optimized mixture. The phase change abilities of FT wax enable EVA co-crystallization with the support of the elastomeric backbone of crumb rubber. Less than 1% loading of FT wax worked in the EVA/crumb rubber modified bitumen energy-sustainability nexus. Response surface methodology approach to the mixture design is implemented amongst the different loadings of FT wax, EVA for a consistent amount of crumb rubber and bitumen. Rheological parameters (complex shear modulus, phase angle and rutting parameter) were the factors used as performance indicators of the different optimized mixtures. The low temperature chemistry of the optimized mixtures is analyzed using elementary beam theory and the elastic-viscoelastic correspondence principle. Master curves and black space diagrams are developed and used to predict age-induced cracking of the different long term aged mixtures. Modified binder rheology reveals that the strain response is not linear and that there is substantial re-arrangement of polymer chains as stress is increased, this is based on the age state of the mixture and the FT wax and EVA loadings. Dominance of individual effects is evident over effects of synergy in co-interaction of EVA and FT wax. All-inclusive FT wax and EVA formulations were best optimized in mixture 4 with mixture 7 reflecting increase in ease of workability. Findings show that interaction chemistry of bitumen, crumb rubber EVA, and FT wax is first and second order in all cases involving individual contributions and co-interaction amongst the components of the mixture.

Keywords : bitumen, crumb rubber, ethylene vinyl acetate, FT wax
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