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Fluxing as a new tool for bitumen rheological characterization and the use of time-concentration shift factor (a_c)

Zoorob SE
Mturi GA
Sangiorgi C
Dinis-Almeida M
Habib NZ

ABSTRACT:

The concept of temperature shift factor (a_T) as defined by Doolittle, relating the free volume of a viscoelastic material at the current and reference states is briefly examined together with the resultant William-Landel-Ferry equation. This paper highlights the fact that change in free volume arise not only from temperature variations but can also result from the absorption of solvents and thus a generalized Doolittle relation may also be applied to a solvent concentration shift factor (a_c). To validate this concept, a small scale laboratory investigation was carried out by blending 40/60 penetration grade bitumen with various proportions of one type of cooking oil and conducting dynamic shear rheometer frequency sweeps at a range of temperatures. By applying time-concentration superposition to each flux content, it was possible to shift horizontally (a_c) each set of complex modulus data measured at each test temperature, so that all sets superimpose onto the master curve of the base bitumen at a preselected reference temperature. A direct relationship between conventional time-temperature shift and the proposed time-concentration shift factors was thus demonstrated using a sample of penetration grade bitumen and one type of vegetable oil. Further experimentation with other bitumen-flux combinations is necessary prior to recommending general adoption of the proposed tool.