INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

DEPARTMENT OF POLYMER AND PROCESS ENGINEERING

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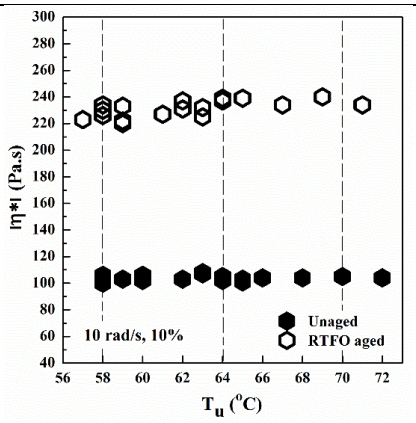
Report: Inputs on IS 73_2013

Comment 1: An alternate/optional test method for Absolute viscosity at 60 °C (IS 1206: Part 2), Kinematic viscosity at 135 °C (IS 1206 Part 3), and Viscosity ratio at 60 °C after RTFO ageing (IS 1206 Part 2): "Complex viscosity (η*) at 60 °C and 135 °C using Dynamic Shear Rheometers".

Justification:

Though the IS 73: 2013 viscosity grading methodology uses simple measurement techniques, it requires seven different instruments. The process is time-consuming and labour-intensive, especially while determining absolute and kinematic viscosity using capillary viscometers. Also, the variation in the two tests is very high. On the other hand, dynamic shear rheometers (DSR) can easily measure bitumens viscosity at different temperatures. The rotational rheometers have advanced tremendously over the last few decades and can provide highly accurate and reliable data. The aim here will be not to replace the existing absolute and kinematic viscosity parameters in IS 73: 2013 but to provide alternate/optional methods using DSR, which will significantly simplify the grading process.

Importantly, in the upper PG grading temperature (Tu) of bitumen, the G*/sinδ rutting criterion is just a surrogate expression of the viscosity of the bitumen. The phase angle (δ) values of bitumen samples generally are ≥ 82° at Tu, which results in sinδ ≈ 0.99. This leads to the simplification of G*/sinδ rutting criterion to G*. From fundamental rheology, we know that complex viscosity η* = G*/ω. Hence, at 10 rad/s, G*/sinδ ≥ 1000/2200 Pa (unaged/RTFO) is the same as η* ≥ 100/220 Pa.s, as shown in the below figure. **In other words, the seemingly complicated method of determining Tu temperature (G*/sinδ ≥ 1000/2200 Pa) is the temperature where the η* of bitumen samples are ≥ 100/220 Pa.s.**



Complex viscosity (|η*|) vs. True PG upper limiting temperature (T_u) for the 18 unaged and RTFO-aged asphalt binders.

- Source: IJPRT, https://doi.org/10.1007/s42947-021-00113-2
- Indian Highways, March 2020

Proposal: In PG grading, a parallel-plate geometry of 25 mm diameter is used to carry out the measurements. We propose using cone-plate geometry for measuring complex viscosity (η*) at 60 °C and 135 °C. This way, we can measure the viscosity of bitumen at 60 °C and 135 °C at just one sample loading. The small gaps in cone-plate geometry will ensure that the bitumen sample does not flow out at 135 °C.

Comment 2: Alternate solvent to check the solubility of bitumen before using 'Trichloroethylene' (IS 1216): First use 'Toulene'.

Justification:

It is known that Trichloroethylene is a **CARCINOGEN**.

"Trichloroethylene ($CICH=CCl_2$) is a colourless liquid with a chloroform-like odour. Trichloroethylene may irritate the eyes and skin. Exposure to high concentrations can cause dizziness, headaches, sleepiness, confusion, nausea, unconsciousness, liver damage, and even death. ***Trichloroethylene is a known carcinogen.*** *Workers may be harmed from exposure to Trichloroethylene. The level of exposure depends upon the dose, duration, and work being done."*

Source: Centre for Disease Control (CDC) and The National Institute for Occupational Safety and Health (NIOSH), USA

Proposal: It has been observed that bitumen samples are readily soluble in 'Toluene'. Hence, we propose that bitumen samples be first checked for solubility using Toluene. If it fails, then Trichloroethylene can be recommended.

Comment 3: Lower temperature to check the Ductility of samples after RTFO ageing (IS 1208).

Justification:

It has been observed that the Ductility at 25 °C after RTFO ageing rarely fails, indirectly implying that the current parameter does not scrutinize the ageing characteristics of bitumen after RTFO ageing.

Proposal: It is important to explore the ductility values of bitumen after RTFO ageing at 15 or 5 °C instead of 25 °C.

Comment 4: Need for a more vigorous RTFO ageing test.

Justification:

It has been observed that RTFO-aged bitumen samples rarely fail the current specification, implying that the current parameter may not intensely scrutinize the ageing characteristics of bitumen.

Proposal: Adopting best practices from other countries in the current IS 73: 2013 standard should be explored. We propose exploring RTFO ageing of bitumen for a longer duration of time (120 minutes).

Comment 5: Mass loss after RTFO ageing

Justification:

Need to include mass loss after RTFO ageing

Best Regards,

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