LTRC RESEARCH PROJECT CAPSULE

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TECHNOLOGY TRANSFER PROGRAM

JUST THE FACTS

Implementation of GPC Characterization of Asphalt Binders at Louisiana Materials Laboratory

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SPR

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SPECIAL POINTS OF INTEREST:

- Problem Addressed
- Objectives of Research
- Methodology Used
- Implementation Potential

PROBLEM

Louisiana has been using polymer modified asphalt cement (PMAC) increasingly for better pavement performance. More often than not, elastomers became the asphalt modifiers of choice due to their excellent elasticity and good compatibility with asphalt species. A new analytical tool is needed for assessing the presence and quantification of the amount of the elastomer modifier, both in a supplied PMAC and in a liquid extracted from pavement cores. Due to a large difference between the molecular mass of polymer molecules and the mass of asphalt components, the polymer can easily be visualized through a size exclusion analysis, such as gel permeation chromatography (GPC). GPC methodology can be applied to routine characterization of asphalt binders and can employ the technique in forensic analysis of paving problems. It traces PMAC dissolved in tetrahydrofuran (THF) solution and styrene-butadiene-styrene (SBS) polymer dissolved in decalin solution. The samples are injected into a set of porous columns and eluted with THF. The order of elution is related to the molecular weight of the component. High molecular weight species elute first followed by molecules with ever decreasing molecular weight. This study will evaluate the amount of the polymeric species in a polymer modified asphalt binder, the changes imparted by the addition of recycled asphalt pavement (RAP) to the mix, and mixes containing a crumb rubber modifier (CRM). Utilization of GPC to monitor the amount of the polymeric material in polymer modified asphalt binders could conceivably establish a better characterization of asphalt materials.

OBJECTIVES

This research will be performed in order to implement a procedure for using GPC as an analytical tool to define the percentage amounts of polymer modifiers in polymer modified asphalt cements. It will also address the quantification of GPC solvent insoluble crumb rubber modifiers present in CRM binders for which a repeated solvent/non-solvent precipitation procedure is being developed. Attention will be also paid to using GPC for assessment of the extent of oxidative aging of modified asphalt binders, forensic analysis of pavement failures, and analysis of asphalt emulsions.

METHODOLOGY

A complete GPC system including a pump, an auto-injector, a column oven, a refractive index (RI) detector, tubing and fittings, a reference column, GPC system workstation software for system control and data handling, and a PC computer and printer configured with workstation software will be utilized. Samples of polymer modified asphalt binders, base asphalt binders, SBS, and CRM asphalt will be obtained from each identified source to establish a catalog of Louisiana PMACs. A hot toluene extraction method will be used to isolate the asphalt binder from field samples.

All asphalt and polymer samples will be prepared at a concentration of 3 percent in THF and injected through weighed 0.45 µm polytetrafluoroethylene (PTFE) filters into 150 µL vials. The residue on the filters will be determined gravimetrically. Samples will be injected with an auto-injector and will be eluted with THF at a flow rate of 1 mL/min at room temperature. The concentration of polymers and asphalt fractions in the eluent will be recorded using a differential refractometer. The separation of the asphalt components will be affected using GPC columns (10 µ packing, 300 x 7.8 mm) connected in a series with a guard column. A set of four columns designed to separate fractions with molecular weight ranges of 1-15 K, 1-75 K, 5-500 K, and 100-10,000 K is the best combination of columns for GPC analysis at room temperature. Based on a previous study, the following molecular weight regions in a PMAC were defined as: very high molecular weight (VHMw polymeric species) 1000-300 K, high molecular weight (HMw polymeric species) 300-45 K, medium molecular weight (MMw aggregated asphaltenes and oxidized polymer species) 45-19 K, asphaltenes 19-3.5 K, and maltenes 3.2-0.1 K. A typical chromatogram will be utilized to compute the relative concentration of the respective fractions. The final percentages of the components should be corrected for the presence of the insolubles. The data compiled will be used to evaluate potential correlations of polymer and asphaltene contents with the rheological properties of the binders studied. Once the best procedure is established for sample preparation, GPC operation, and data interpretation, a protocol will be written for LADOTD laboratories.

IMPLEMENTATION POTENTIAL

Basically the research will potentially impact HMA producers, asphalt producers, highway paving contractors, and LADOTD. All could conceivably benefit from the utilization of this new analytical tool in order to monitor the amount of the polymetric material (rubber) in a polymer modified asphalt binder from the inception of a project to the exploitation of a pavement.

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