Florida Department of Transportation
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DEVELOPMENT OF A SUITABLE PROCEDURE FOR SIMULATING AGING EFFECTS OF HOT-MIXING ON MODIFIED ASPHALTS FOR USE IN SUPERPAVE BINDER SPECIFICATIONS

PROBLEM STATEMENT

Superpave binder specifications require that an asphalt binder under evaluation be subjected to (1) a standard Rolling Thin Film Oven Test (RTFOT) (ASTM D2872-97, 1999), which simulates the effect of hot-mixing, and (2) a Pressure Aging Vessel (PAV) process, which simulates several years of field aging. Previous research has shown that this aging method is suitable for use on conventional asphalts, but not on modified asphalts. Asphalts modified with coarse ground tire rubber (GTR) and styrene butadiene rubber (SBR) tend to spill from the RTFOT bottles during the RTFOT process. When the TFOT process (ASTM Dl 754-97, 1999) was used instead of the RTFOT process, a thin skin tended to form on the surface of some modified asphalt samples, reducing the homogeneity and the aging of the samples.

Since 1988, GTR has been increasingly used in friction course mixtures by the Florida Department of Transportation (FDOT). A ten-year performance evaluation of asphalt-rubber friction course mixes in Florida has shown that the amount of cracking was relatively insignificant and that less rutting occurred with the use of GTR (Choubane et al., 1999). Due to the increasing use of GTR-modified asphalts and the potential use of other modified asphalts in Florida, it is crucial that a suitable laboratory aging method be developed to replace RTFOT and TFOT, so the aging characteristics of these modified asphalts can be properly determined.

OBJECTIVES

The rotavapor apparatus is commonly used for the recovery of asphalts from solutions in accordance with ASTM D5404-97 (1999). In this study, the rotavapor was modified to work as an aging device for asphalt, with the following objectives:

- To investigate the feasibility of the rotavapor apparatus for simulating short and long-term aging of conventional and modified asphalts.
- To develop an effective and convenient test set-up and procedure that can be used in place of RTFOT and TFOT for simulating the aging effects of hot-mixing on conventional and modified asphalts.
- To develop an effective and convenient test set-up and procedure which can be used in place of the PAV procedure for simulation of long-term aging of conventional and modified asphalts in service.
- To evaluate the applicability of the new aging procedure to replace the RTFOT and PAV

processes in the Superpave binder specifications.
- To investigate the problem with extraction and recovery of rubber asphalt binder from rubber asphalt mixtures.

FINDINGS AND CONCLUSIONS

The findings may be summarized as follows:

- The rotavapor apparatus was successfully modified to work as an aging device for both conventional and modified asphalts. Test results indicated that the aging severity of the modified rotavapor aging process is affected by variables such as process temperature, process duration, and sample size. Smaller sample size, longer process duration, and higher process temperature produce significantly more severe aging effects.
- The temperature variation in the oil bath of the rotavapor apparatus was substantially reduced by coverng the oil bath with a well-insulated box.
- The Modified Rotavapor Aging process at 163 ^{0}C, 200 g sample size and 165 minutes duration produced aging severity similar to that of the TFOT, while the Modified Rotavapor aging process at the test configuration of 163 ^{0}C, 200 g and 210 minutes produced aging severity similar to the RTFOT.
- Based on the limited data from this study, it was found that to produce aging severity similar to TFOT+PAV or RTFOT+PAV, the Modified Rotavapor aging process can be run at 163 ^{0}C for 615 minutes using a sample size of *125* g.
- The rubber asphalt in the rubber asphalt mixture could not be completely extracted in the reflux extraction process. Most of the rubber particles remain on the filter paper and stick to the aggregates during the extraction process. A small amount of asphalt binder also remains in the aggregate and cannot be completely extracted. The percent of rubber and asphalt remaining on the filter paper in the reflux extraction process was different for each mixture.
- The extracted aggregate from the Reflux extraction should be left in a desiccator to cool to room temperature after drying in an oven. The weight of the extracted aggregate stabilizes after 3 hours in a dessicator and thus represents its true weight at room temperature. Therefore, this weight should be used for calculating the extracted AC content to eliminate the possible effects of moisture in air on the results.
- All asphalt binders aged in the Modified Rotavapor aging process experienced a mass loss very close to those aged in the TFOT and RTFOT processes.
- The PG grades of both the conventional and the rubber modified asphalts used in this study were not affected by using the Modified Rotavapor Aging process in place of RTFOT in the Superpave Binder Specifications.
- The results from this study verified the prior finding that RTFOT is a more severe short-term aging process than is TFOT.

The developed rotavapor aging process and procedure proved to be a versatile method for simulating different levels of aging on various amounts of pure and modified asphalts.

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