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EVALUATION OF AN ALTERNATIVE SOLVENT FOR EXTRACTION OF ASPHALT TO REDUCE HEALTH HAZARDS

PROBLEM STATEMENT

The asphalt extraction and recovery procedure is a vital part of the quality control and assurance of asphalt pavement recycling projects in Florida. A solvent used in the extraction and recovery procedure, trichloroethylene (TCE), has been identified as carcinogenic and environmentally hazardous, contributing to the depletion of the ozone layer. Consequently, TCE will likely be banned in the near future under the U.S. Clean Air Act. Therefore, in order to maintain present testing methods, a less hazardous and suitable replacement for TCE needs to be found.

OBJECTIVES

The purpose of this study was (1) to test the suitability of using EnSolv, an n-Propyl Bromide based solvent produced by EnviroTech International, as a replacement for TCE in the asphalt solubility, extraction, and recovery tests, and (2) to test the reclaimed EnSolv obtained from the recovery for potential re-use in the extraction and recovery procedure.

FINDINGS AND CONCLUSIONS

The standard asphalt solubility test (ASTM Test Method D2042) was conducted on eight different asphalt binders using EnSolv and TCE. The results indicated that there was no practical difference between the two solvents. The maximum difference in results from the two solvents was 0.11%. Further, this test method does not need to be modified when using EnSolv as the solvent.

Asphalt extraction and recovery tests were performed on three different asphalt mixtures using TCE, EnSolv, and reclaimed EnSolv. The mixtures used for the study included Marshall, Superpave, and crumb rubber modified asphalt mixtures. The Marshall and Superpave mixtures both contained some RAP (Reclaimed Asphalt Pavement). The Reflux extraction procedure (ASTM standards D2172 - Method B) and the Rotary Evaporator recovery procedure (ASTM D 5404) were used to extract and recover the asphalts, as well as another procedure suggested by the FDOT, which uses a higher rotating speed and vacuum for easier and quicker operation. The results from the asphalt extraction tests indicate that, from the standpoint of asphalt content determination and extraction time, EnSolv and reclaimed EnSolv would be suitable to replace TCE for the ASTM D 2172 Method B extraction procedure. The testing methods are applicable for the use of EnSolv as well as reclaimed EnSolv. In fact, the use of the EnSolv and reclaimed EnSolv actually reduced the time required to complete the extraction test.

The results of the recovery tests indicated that binders could be recovered faster from EnSolv and reclaimed EnSolv than from TCE. The FDOT proposed recovery method was found to take less time and to be much easier to perform.

The binders recovered from the mixtures were tested and analyzed to see if there were any differences due to the use of different solvents. The binder tests that were performed on the recovered binders included (1) penetration at 25 °C, (2) the Brookfield viscosity test at 60 °C, (3) the dynamic shear rheometer test at 25 and 64 °C, (4) the bending beam rheometer test at -18 °C, and (5) FTIR spectral analysis. The results from the tests on the recovered binders indicated that, for the most part, EnSolv and reclaimed EnSolv were not significantly different from TCE. The results also indicated that the binders recovered by the FDOT proposed recovery procedure were not significantly different from those recovered by the standard ASTM method.

An evaluation of the effects of TCE, EnSolv, and reclaimed EnSolv on the physical properties of asphalt binders was also performed. A virgin asphalt binder was dissolved in each of the three solvents and recovered in accordance with the ASTM D 5404 recovery procedure. The physical properties of the recovered binders were measured and compared with the properties of the virgin binder. The binder tests on the recovered binders included (1) penetration at 25 °C, (2) the Brookfield viscosity test at 60 °C, (3) the dynamic shear rheometer test at 25 °C and 64 °C, (4) the bending beam rheometer test at -18 °C, and (5) FTIR spectral analysis. Test results indicated that, for the most part, the binders recovered from TCE and reclaimed EnSolv were similar to the virgin binder. However, significant hardening of the binders was noted for the binders recovered from the fresh EnSolv, as demonstrated by the results of the penetration, Brookfield viscosity, and dynamic shear rheometer tests. The observed hardening effect of the fresh EnSolv appeared to apply only to unaged virgin binders, and not to binders in asphalt mixtures which had already undergone some aging.

A sample of EnSolv and a sample of reclaimed EnSolv were analyzed at the Department of Chemistry of the University of Florida to determine their compositions. Results of GC-MS Analysis (Gas Chromatography - Mass Spectrometry) and ^{1}H nmr (nuclear magnetic resonance) spectroscopy on EnSolv indicated its composition to be reasonably consistent with composition as reported in the MSDS prepared by Enviro-Tech International, Inc.

Available information regarding the safety of Ensolv suggests that it appears to be a viable alternative to TCE. The material should, nevertheless, be considered hazardous, and appropriate precautions should be exercised during its storage, transportation, handling, and use. Inhalation, ingestion, and skin contact should be avoided.

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