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Ethanol based foamed asphalt as potential alternative for low emission asphalt technology

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ABSTRACT

Foamed asphalt typically relies on water as a foaming agent because water becomes gaseous at elevated temperatures, generating numerous tiny bubbles in the asphalt and causing spontaneous foaming. In this study, ethanol was used as a potential alternative to water as a foaming agent. Ethanol is expected to be a physical blowing agent in the same manner as water, except it requires less energy to foam due to its 78 °C boiling point. This study compares the performance of water and ethanol as foaming agents through the measurements of rotational viscosity, the reduction in temperature during foaming, and volatile loss. The ethanol-foamed asphalt binders were prepared at 80 °C and 100 °C, while the water-foamed asphalt binders were prepared at 100 °C and 120 °C. Additionally, the rolling thin film oven (RTFO) was used to generate short-term aging of the foamed asphalt binders. A rotational viscometer was used to determine the viscosity of the asphalt binders at 80 °C, 100 °C, 120 °C, 140 °C, and 160 °C. Overall, ethanol can function in the same manner as water but requires less energy to foam. It is proven based on the smaller drop in temperature of the asphalt binder foamed using ethanol compared with that prepared with water. This is due to the lower latent heat capacity of ethanol, which requires less energy to vaporize compared with water. Through the rotational viscometer test, ethanol performs better in lowering the viscosity of asphalt binders, which is essential in allowing production processes at low temperatures, as well as a better workability and aggregate coating. Ethanol can be expelled from the foamed asphalt binders at a higher rate due to its lower boiling point and latent heat.

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1. Introduction

Over the past years, extensive measures, like those to reduce air pollution and sustainable development protocols, have been taken by numerous organizations to reduce the severity of pollution. In order to support sustainable development, warm mix asphalt (WMA) was invented in Europe and further developed in the continent and other countries to permit hot mix asphalt (HMA) to be produced at a lower temperature to help lower the energy demand and greenhouse gas emissions, as well as create better working conditions for construction workers and plant operators (Gandhi and Amirkhanian, 2007; Goh and You, 2012; Hurley and Prowell, 2005a, 2005b, 2006; Prowell et al., 2007; Wasiuddin et al., 2007). A few WMA technologies were introduced including foaming methods, organic additives, and chemical additives (Chowdhury and Button, 2008). The energy savings, emission reductions, and lower construction costs can be enhanced if the production process is conducted at even lower temperature settings, especially when WMA foaming methods are used (Colbert et al., 2016). Asphalt foaming techniques have been used over the last couple of decades as an alternative to traditional methods in preparing asphalt mixtures. The water-based

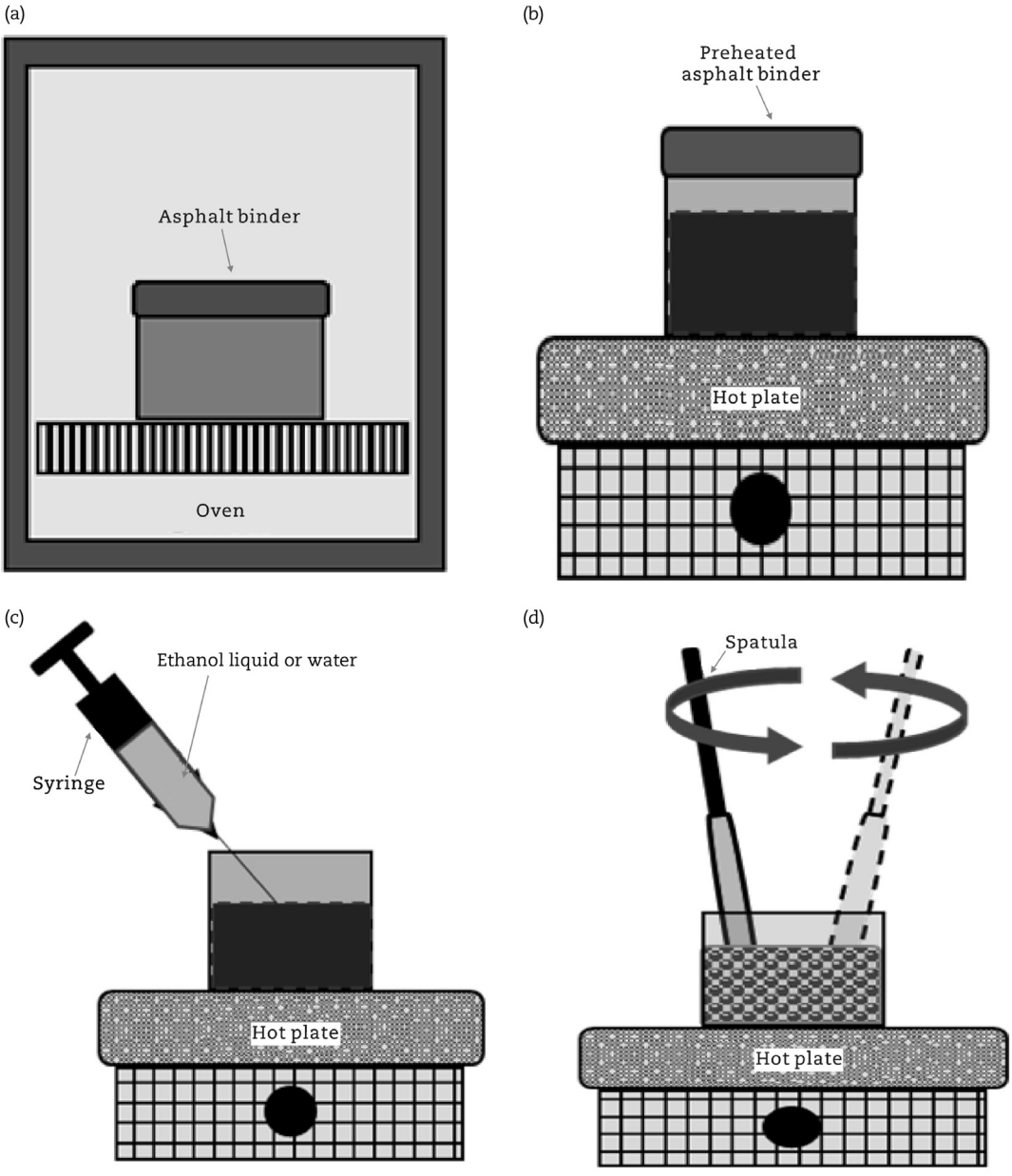

Fig. 1 – Preparation of the foamed asphalt. (a) Preheat the asphalt binder that was initially poured into a small container in an oven at the test temperature. (b) Place the container with asphalt binder on a preheated hot plate. (c) Add in specified amount of foaming agent (ethanol or water). (d) Stir the binder and the foaming agent(s) for about 30 s before recording the temperature.