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RESEARCH ARTICLE-CIVIL ENGINEERING

Evaluating the Chemical and Rheological Attributes of Aged Asphalt: Synergistic Effects of Maltene and Waste Engine Oil Rejuvenators

Zaid Hazim Al-Saffar[1] · Haryati Yaacob[1] · Mohd Khairul Idham Mohd Satar[1] · Mhmood Khleel Saleem[2] · Ramadhansyah Putra Jaya[3] · Choy Jau Lai[4] · Ekarizan Shaffie[5]

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Abstract
The service life of road pavement reduces as it ages and loses its properties due to the exposure to varying traffic loads and climatic conditions. This study explores the potential rejuvenation of the aged asphalt properties to enable it to be reused in pavement by adding hybrid rejuvenator (WEO-MLT). The WEO-MLT is composed of waste engine oil and maltene (MLT). Four types of binders, namely virgin asphalt, aged asphalt, 40% aged asphalt and rejuvenated asphalt, were prepared and evaluated via rheological and chemical tests [e.g. storage stability, asphaltene-to-MLT ratio, dynamic shear rheometer, bending beam rheometer, Fourier transform infrared (FTIR), thermogravimetric analysis and stripping resistance tests]. The results revealed that the WEO-MLT markedly enhanced the properties of aged asphalt at low and high temperatures. In contrast, the outcomes of FTIR suggested that the ageing properties of asphalt were not improved significantly by WEO-MLT due to the presence of a carboxyl group in its composition. TGA indicated that the initial decomposition for rejuvenated asphalt was approximately close to virgin asphalt. The stripping resistance test divulged the comparable performance of the rejuvenated asphalt to that of virgin asphalt. Therefore, WEO-MLT can be potentially used in the rejuvenation of the aged asphalt, paving the way to sustainable and eco-friendly asphalt production.

Keywords Asphalt · Reclaimed asphalt pavement · RAP · Aged asphalt · Rejuvenating agent · Hybrid rejuvenator

1 Introduction

Recently, universities in Malaysia have proposed many initiatives for managing waste. Most proposals are geared towards increasing public awareness about the importance of minimizing landfill discard of waste materials [1]. One of the recyclable material possessing the potential to be used in improving the sustainability and cost-effectiveness of road pavement production is the reclaimed asphalt pavement (RAP) [2, 3]. However, the drawbacks in RAP asphalt binder include hardening of asphalt binder with age as a result of oxidation, alterations of molecular structure, loss of volatiles during construction, high levels of ultraviolet (UV) and traffic load [4, 5]. Compared to virgin asphalt, an asphalt binder of higher stiffness is obtained when aged and hardened RAP-derived asphalt binder are mixed with virgin asphalt binder [5, 6]. Furthermore, the processes of mixing and construction are likely to diminish workability [7], which is difficult to use the RAP in the pavement [8].

The use of rejuvenating agents may be a solution to decrease the stiffness of the aged asphalt. For example, waste

✉ Haryati Yaacob
haryatiyaacob@utm.my

1 School of Civil Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia

2 Department of Chemical Industry, Mosul Technical Institute, Northern Technical University, Mosul, Nineveh 41001, Iraq

3 College of Engineering, Department of Civil Engineering, Universiti Malaysia Pahang, 26300, Gambang, Pahang, Malaysia

4 Department of Bioprocess and Polymer Engineering, School of Chemical and Energy Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia

5 Institute for Infrastructure Engineering and Sustainable Management, Faculty of Civil Engineering, Universiti Teknologi Mara, 40450 Shah Alam, Selangor, Malaysia

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