

STORAGE STABILITY OF BITUMEN MODIFIED BY THE ADDITION OF GROUND RUBBER, SWOLLEN SBS AND POLYMERIC SHORT FIBERS

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ABSTRACT:

Bitumen is used as binder for asphalted roads worldwide. However the service life of asphalt roads is limited due to the viscoelastic properties of bitumen. The lack of yield stress and the flow behavior at high temperatures as well as the stiffness of bitumen at lower temperatures results in the main failure sources of asphalt roads. Many polymers have been used in industry to improve the rheological behavior of bitumen and consequently, service life of roads. The polymers are commonly added to hot bitumen under stirring in order to achieve a stable dispersion. However, most polymers show little to no miscibility in bitumen, which requires long dispersion times and may lead to oxidation of bitumen and degradation of the polymers. Poor miscibility of the dispersed polymer and the bitumen matrix can result in phase separation during transport of molten bitumen, leading to a heterogeneous binder and further failure of the paved road, which is a common problem in the paving industry. Rubber pre-treating leads to a faster mixing process without compromising dispersion quality and stability. Bitumen was modified with SBS, ground rubber and chopped fibers of polymers. These fibers, which showed good stability, can be considered for the future as bitumen modifiers. To evaluate the stability of the modified bitumen, we propose a stability index.

ZUSAMMENFASSUNG:

Bitumen wird als Bindemittel für asphaltierte Straßen weltweit eingesetzt. Allerdings ist die Lebensdauer von Asphaltstraßen aufgrund der viskoelastischen Eigenschaften von Bitumen beschränkt. Sowohl die Nichtexistenz einer Fließgrenze und das Fließverhalten bei hohen Temperaturen als auch die Sprödigkeit des Bitumens bei niedrigeren Temperaturen gehören zu den wichtigsten Versagensgründen bei Asphaltstraßen. In der Industrie sind viele Polymere versuchsweise eingesetzt worden, um das rheologische Verhalten von Bitumen und folglich die Lebensdauer des Asphaltbelags von Straßen zu verbessern. Die Polymere werden üblicherweise mit heißem Bitumen unter Rühren gemischt, um eine stabile Dispersion zu erreichen. Allerdings zeigen die meisten Polymere wenig bis keine stabile Mischbarkeit mit Bitumen, so dass für die Dispersion der Polymere im Bitumen lange Zeiten benötigt werden und dies zur Oxidation von Bitumen und zum Abbau der Polymere führen kann. Schlechte Mischbarkeit des dispergierten Polymers mit Bitumen kann zu Phasentrennung während des Transports von flüssigem Bitumen führen und als Folge zu einem heterogenen Binder und zu Schwachstellen im Asphaltbelag, was ein häufiges Problem im Straßenbau ist. Wie wir zeigen konnten, führt eine Vorbehandlung von Gummi zu einem schnelleren Mischvorgang ohne Qualitäts- und Stabilitätsverlust der Dispersion. Bitumen wurde mit SBS, gemahlenem Gummi und kurzen Polymerfasern modifiziert. Diese Fasern, die eine gute Stabilität zeigen, können zukünftig als Zusatzstoffe für Bitumen interessant werden. Um die Lagerstabilität des modifizierten Bitumens zu bewerten, schlagen wir einen Stabilitätsindex vor.

RÉSUMÉ:

Le bitume est utilisé dans le monde entier comme liant pour les routes asphaltées. Néanmoins, la longévité des routes asphaltées est limitée du fait des propriétés viscoélastique du bitume. Son manque d'élasticité et sa plasticité à haute température ainsi que sa rigidité à basse température, sont les sources principales des dégâts occasionnés sur ce type de routes. Plusieurs polymères ont été utilisés dans l'industrie afin d'améliorer le comportement rhéologique du bitume et de fait la longévité des routes. Les polymères sont généralement ajoutés au bitume à chaud sous agitation, dans le but d'assurer un homogénéisation stable. Toutefois, la plupart des polymères ont une faible, voir aucune miscibilité avec le bitume, ce qui requière des temps d'homogénéisation plus longs, qui peuvent induire une oxydation du bitume et une dégradation des polymères. Leur faible miscibilité ainsi que la matrice du bitume peuvent impliquer une séparation de phases lors du transport du produit fondu et former un liant hétérogène, qui générera à postériori des dégâts sur les chaussées, ce qui est un problème commun pour l'industrie du revêtement. Un pré-traitement avec du caoutchouc permet un mélange plus rapide en préservant l'homogénéité, ainsi que la qualité et la longévité du produit. Le bitume a été modifié avec du SBS, des caoutchouc naturels et des fibres de polymères hachées. Ces fibres montrant une bonne stabilité peuvent être considérés comme les modifiant futurs du bitume. Afin d'évaluer la stabilité du bitume ainsi modifié, nous proposons un index de stabilité.

KEY WORDS: rheology, bitumen, asphalt, storage stability

indices \bar{S}_{i-T} and $\bar{S}_{i-\omega}$ show good correlation between each other, and can be used to characterize quantitatively the stability of modified bitumen in temperature and frequency sweep tests. These indices can be simply used for quality control purposes with less uncertainty than the commonly used parameter η_o . Devulcanizing of ground-rubber did not showed conclusive advantages in rheological properties. Therefore, it is not suggested mechanical kneading of ground rubber. Bitumen modified with polymeric fibers showed fair to good stability, however, the addition of chopped fibers of poly(ar-amide) and poly(ar-ester) is limited to low concentrations. Due to the high mixing efficiency of pre-treated SBS, future work should be focused on bitumen modification in a continuous or semi-continuous process, such as twin-screw kneader/reactors.

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