ENCAPSULATED REJUVENATORS FOR ASPHALT

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ABSTRACT

Asphalt concrete is one of the most common types of pavement surface materials used in the world. It is a porous material made at very high temperatures (~180 ^{o}C) that consists of a mixture of asphalt binder (bitumen), aggregate particles and air voids. After some years of use, the stiffness of asphalt concrete increases, its relaxation capacity decreases, the binder becomes more brittle, micro-cracks develop in it and cracking of the interface between aggregates and binder occurs. This mainly happens as a result of oxidation, which consists of the combination of the hydrocarbon compounds of bitumen with oxygen. Asphalt binders are usually simplified in two subdivisions: a solid one called asphaltenes and a liquid one called maltenes. During the oxidative process, asphaltenes content is increased, while maltenes decrease: the solid phase increases and the liquid phase decreases, resulting in a rigidity increase of the pavement.

To restore the pavement original properties, one of the most effective methods are rejuvenators, which most important goal is to restore the asphaltenes/maltenes ratio. Rejuvenating agents, consist of lubricating and extender oils, which contain a high proportion of maltene constituents. In general, rejuvenating agents should be highly aromatic, and if so, both hardening susceptibility and temperature susceptibility are generally improved. They should be composed in such a way that they increase the peptizing power of the maltene phase.

The problem is that, for a rejuvenator to be successful, it must penetrate the pavement surface. In [1] three rejuvenators, one cutback asphalt and two emulsions (one tar based and the other asphalt based) were applied on a 12-year-old parking lot pavement to assess their effectiveness. It was found that none of them penetrate into the pavement more than 2 cm. Otherwise; in this paper it is shown how the application of the rejuvenators causes a high reduction in the surface friction of pavements with high macro-texture depth. Finally, with these materials, the road must be closed for some time after their application and besides, they may be dangerous for the environment.

To solve these problems, authors will present a new concept in road construction: encapsulated rejuvenators. Their basic principle is that when the stress in the capsules embedded in the asphalt reaches a certain threshold value, the capsules break and some rejuvenator is released, restoring the original properties of the pavement. In
Figure 1 (a) an optical micrograph of the core materials of the capsules is shown. It can be seen that externally they look as aggregates, with their surface very uniform and no external signs of the rejuvenator inside. To allow viewing the capsules morphology they have been embedded in epoxy

resin and, once the resin was hardened, it has been polished until some representative sections of the capsules were exposed.

Figure 1 (b) shows a section of the porous sand inside the capsules where multiple micropores can be observed.
Figure 1 (c) shows a section of a capsule which comprises two distinct regions: the core and the shell. In this Figure it can be clearly seen that the shell has three different layers with variable density: the shell is completely made of a mixture of epoxy and cement, but the density changes a lot from the inside to the outside of the capsule. Finally, in
Figure 1 (d) a detail of the shell is shown with the very high packaging density of the shell materials close to the porous sand, which prevents the rejuvenator from coming out, and that this density reduces towards a rough surface on the outside of the capsule. This is very positive because the rough surface will increase the bonding level with the binder.

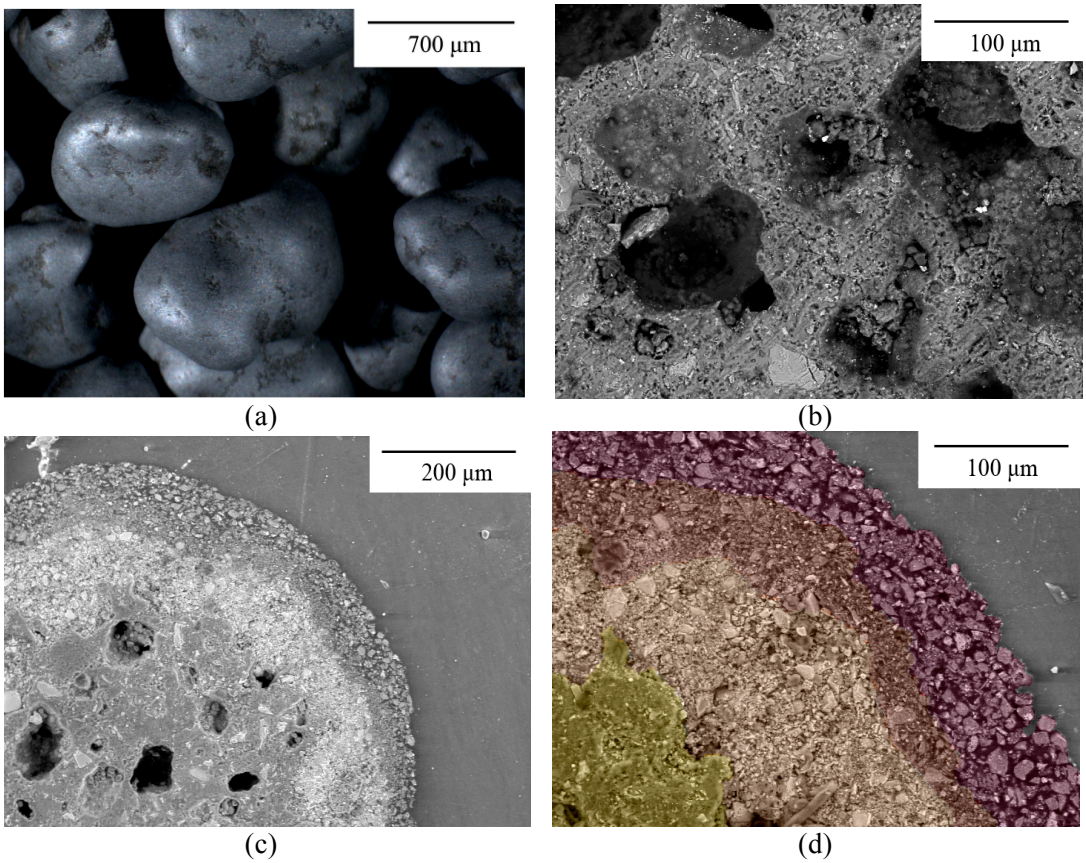

Figure 1: (a) Optical micrograph of the core materials of the capsules. (b) SEM image of the porous sand used. (c) SEM image of a capsule section showing its different layers. (d) A detail of the shell materials showing the very dense interior wall and the rough exterior of the wall.

This paper is the result of the project "Unravelling of Porous Asphalt", held at the TU Delft during the last three years. This work will be continued in a new project called "Encapsulated Rejuvenators for Asphalt", where two main areas will be explored: 1. Self rejuvenation of asphaltic materials (pavements, joints, railbeds for transit systems, etc.) through the addition of encapsulated rejuvenators and 2. the modelling and optimization of these capsules containing rejuvenators to find out their main working parameters and reach a complete understanding of hot they work.

REFERENCES

[1] J. Shen, S. Amirkhanian, J.A. Miller, Effects of rejuvenating agents on superpave mixtures containing reclaimed asphalt pavement, *Journal of Materials in Civil Engineering*, **19**, 5, 2007, pp. 376-384.