

APPLICATION PROSPECT OF WASTE VEGETABLE OIL USED IN ASPHALT RECYCLING

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Анотація: Для того, щоб гарантувати дорожні характеристики переробленої асфальтобетонної суміші, необхідно додати онвлюючий засіб на рекультивоване асфальтове покриття (RAP). Згідно з теорією регенерації асфальту та відповідними дослідженнями, відходи рослинного масла, стануть онвлюючим агентом рекультивованого асфальтобетонного покриття (RAP), реалізуючи одночасне використання відпрацьованої рослинної олії та відходів асфальтобетонного покриття, що є корисним для охорони навколишнього середовища.

Ключові слова: відпрацьована рослинна олія; асфальт; омолоджуючий засіб; виконання тротуару.

Abstract: In order to guarantee the road performance of the recycled asphalt mixture, it is necessary to add rejuvenate agent to the reclaimed asphalt pavement (RAP). According to the theory of asphalt regeneration and related research, waste vegetable oil is expected to become a rejuvenate agent of reclaimed asphalt pavement (RAP), realizing the simultaneous utilization of waste vegetable oil and waste asphalt pavement materials, which is beneficial to environmental protection.

Keywords: waste vegetable oil; asphalt; rejuvenate agent; pavement performance.

Introduction

At present, after a large area of early disease on the asphalt pavement occurs, especially the pavement structural disease, the main maintenance method is to pave the asphalt concrete again after milling the old pavement, resulting in a large amount of reclaimed asphalt pavement (RAP). The asphalt regeneration technique provides us with a new idea to solve this problem, after treatment, the reclaimed asphalt pavement (RAP) will be remixed with new asphalt, new mineral materials, rejuvenate agent, etc. to form the pavement according to the road requirements and industry standards[1, 2]. The application of asphalt regeneration technique can not only greatly improve the technical efficiency and production efficiency, but also improve the high temperature stability and strength of recycled asphalt mixture better than the new asphalt mixture due to the aging of asphalt in reclaimed asphalt pavement (RAP), for areas with special road performance requirements, recycled asphalt mixture helps to extend the service life of the pavement[3].

Waste vegetable oil refers to the waste oil produced in cooking and food processing, including frying oil, catering waste oil, etc.; if directly discharged, it will pollute the environment, such as water eutrophication. Studies have shown that 1kg of waste vegetable oil flowing into water can pollute 15,000 square meters of water surface[4]. At present, waste vegetable oil has become an environmental pollutant, which has impacted food safety and seriously endangered people's physical and mental health. The comprehensive utilization of waste vegetable oil has attracted more and more attention.

Research results

At present, asphalt regeneration theory mainly includes component adjustment theory and consistency theory[5, 6]. The component adjustment theory based on the chemical components, compares the components of the aging asphalt and the original asphalt, and adds the lost components to the aging asphalt to re-coordinate the components and restore the original performance of the asphalt. Consistency theory based on chemical thermodynamics and believes that mixing a certain rejuvenate agent to reduce the solubility parameters differences between asphalt components, then asphalt can be regenerated[7, 8]. In fact, these two theories are essentially the same, there is no conflict, but complement each other. Asphalt is composed of asphaltene, gum (resin) and oil (saturated fragrance and sweet fragrance), and there is a certain

correlation between asphalt component and its performance. After the asphalt is aged, it is mainly manifested as a decrease in saturated fragrance, an increase in gum and asphaltene, and performance indicators are reflected in the decrease in penetration, increase in softening point, increase in viscosity, decrease in ductility, increase in complex shear modulus and creep stiffness, indicating that the elasticity, temperature susceptibility, and resistance to fatigue cracking of the aged asphalt become worse, thus shortening the service life of the road[9, 10].

From the chemical point of view, asphalt regeneration is the reverse process of aging. It is usually based on the consistency theory to reconcile the components of the regenerated asphalt and to restore its performance by adding new asphalt or rejuvenate agents containing appropriate chemical components into the aged asphalt. At present, the main components of asphalt rejuvenate agent are low viscosity components, adding plasticizer, anti-aging agent, etc [11]. The main component of waste vegetable oil is oil, which can theoretically be used as a low-viscosity component for the regeneration of aging asphalt, and can be used for asphalt regeneration by mixing with some additives[12, 13].

There have been a small amount of research reports on the use of waste vegetable oil in asphalt regeneration in recent years. Asli et al.[14] found that waste vegetable oil can be used as an asphalt rejuvenate agent and improve the physical properties of aged asphalt. Chen et al.[15, 16] utilized frying vegetable oil to rejuvenate aged asphalt, and the study showed that frying soybean oil significantly improved the fatigue property and low temperature anti-cracking property of aged asphalt, but the ductility was not effectively improved, and high temperature performance became poorer with the increase of frying soybean oil. Zhang et al.[17] appraised the effects of vegetable oil with different deep-frying times on the rheological performance of aged asphalt, and the study exhibited that vegetable oil of a higher aging degree could result in a higher viscosity and a better rutting resistance.

Waste vegetable oil is a kind of rancid oil that seriously exceeds the standard, but it is also a very important resource because it contains various fatty acids. Over the years, many countries have carried out a lot of research on the reuse of waste vegetable oil. At present, there are two main ways to use waste vegetable oil: (1) The fatty acid is extracted by hydrolysis to prepare products, such as soap and glycerin. The main disadvantage is that the amount of utilization is too small, and the use of sulfuric acid in the hydrolysis will produce a lot of acid water, causing secondary pollution; (2) Alcoholysis to prepare biodiesel is a very good direction, but the existing technology has disadvantages such as high cost, difficult recovery of catalysts, prone to side reactions, high energy consumption and environmental pollution. Both of these two methods will produce secondary pollution, and the quality requirements of waste vegetable oil are relatively high, and treatments such as filtration, dehydration, deodorization, decolorization, deacidification and viscosity reduction are required[18-22]. The quality requirement of waste vegetable oil for asphalt regeneration is relatively low, and it can broaden the way of resource utilization.

Currently, the materials used for asphalt regeneration mainly include asphalt emulsion, foamed asphalt, soft asphalt, rejuvenate agent, etc.[23], among which the rejuvenate agent is generally crude oil distillation products (such as diesel, engine oil, lubricating oil, etc.) and other mineral oils and resins rich in aromatic hydrocarbon. However, there are some problems, for example, although light oils such as diesel oil and motor oil have good penetration and softening effects on asphalt, their flash point is low, generally less than 100°C, so the safety is low; The high and low temperature performance of heavy mineral oil regenerated asphalt is not ideal, and the modifier is expensive; Other mineral oils rich in aromatic hydrocarbons will release toxic gases that are harmful to the human body during high-temperature heating; The most important thing is that petroleum is a non-renewable resource. The predecessor of waste vegetable oil is natural oil, which has the characteristics of large quantity and low price, high flash point and low viscosity. At the same time, it has strong heat resistance after high temperature process, and asphalt can solidify harmful substances in waste vegetable oil. Therefore, the use of waste vegetable oil in the regeneration of aged asphalt has its own advantages.

The use of waste vegetable oil in asphalt regeneration is a complex process. The source and composition of waste vegetable oil are varied, and the composition of waste asphalt is complex. The effect of waste vegetable oil on asphalt regeneration is influenced by multiple factors, which makes it more difficult to study the application of waste vegetable oil on asphalt regeneration. Whether waste vegetable oil can be successfully used in the recycling of waste asphalt pavement materials, there are still a series of key technical problems to be solved: (1) The source and composition of waste vegetable oils vary. Different waste vegetable oils have completely different physical and chemical properties. How to classify and treat them is the basis for the application of waste vegetable oils to the regeneration of waste asphalt pavement materials.

(2) The regeneration effect of waste vegetable oil on aging asphalt is an important criterion for the successful application of waste vegetable oil to the recycling of waste asphalt pavement materials. Studying and analyzing the influence of the mixing of waste vegetable oil on various properties of asphalt and asphalt mixtures is the key to further optimizing the regeneration effect of waste vegetable oil on aged asphalt.

Conclusion

Both waste vegetable oil and aged asphalt are two kinds of wastes that are urgently needed for resource utilization. Currently, people have begun to realize that waste vegetable oil can be used for the regeneration of aged asphalt, but systematic research has not been carried out yet. The use of waste vegetable oil in the recycling of waste asphalt pavement materials can broaden its resource utilization approaches, and at the same time, it can provide large quantities of cheap raw materials for the recycling of waste asphalt pavement materials. In order to realize the application of waste vegetable oil in the recycling of waste asphalt pavement materials, the research on the classification and treatment technology of waste vegetable oil and the regeneration effect should be focused on to provide theoretical basis and technical guidance for its practical engineering application.

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