The Development and Application of Liquid Waste Rubber Asphalt Modifier

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Abstract. A liquid waste rubber is treated by appropriate scrap tire rubber into a liquid rubber of a new type of waste rubber application mode. This paper uses the physics of low temperature atmospheric pressure chemical decomposition method and adding softeners make waste rubber softening full swelling decomposition method at the same time two-way reaction, physical change and chemical change of dual phase at the same time reaction to produce liquid regenerated rubber purpose. Liquid waste rubber products used for waste rubber provides a simple process, less investment, environmental protection and energy saving, wide application, good economic benefits of waste rubber utilization mode, and is worthy of popularization and application development.

Introduction

Rubber asphalt technology has been widely used in road engineering and research has become increasingly mature. Although the traditional rubber asphalt processing technology can improve the performance of matrix asphalt to some extent, it has the disadvantages of high temperature processing easy aging, poor storage stability, easy segregation and precipitation resulting in quality instability and other shortcomings. In addition, the traditional rubber asphalt site processing will cause pollution to the local environment, the site construction personnel's health will also cause some potential harm; Among the existing methods of preparing modified asphalt by wet rubber powder, there is also a centralized supply mode of desulphurizing rubber powder to some extent. Although the stability of rubber modified asphalt is better than that of traditional rubber modified asphalt, the content of rubber powder is generally low, and its performance is generally not up to the specific performance level of rubber asphalt. In the rubber industry, there are also using waste rubber powder processed into liquid to produce liquid rubber but used as asphalt waterproof materials composition. Throughout the domestic and foreign related research data, it shows that the waste rubber powder processed into liquid used as road bitumen modifier research has not been reported.

We learn from the advantages and disadvantages of waste rubber powder modified asphalt, develop and design the new modifier formula in order to try to keep the excellent performance of the original rubber powder modified asphalt and overcome its deficiency factors, forming a new asphalt modified additive. The successful development of the additive has the following positive significance:

1) The additive can change the waste rubber powder from solid phase to liquid phase by a certain processing technology, which can be easily dissolved in semi-liquid phase of asphalt, so that it change the phenomenon that the original rubber powder is difficult to dissolve in asphalt but easy to isolate.

2) It has solved the problem that the waste rubber powder absorbs the light oil in a large amount of asphalt during the swelling process, which makes the asphalt hard and brittle.

3) It can adjust different asphalt formulations, such as number 50-70 asphalt with the right amount of the additive, into the specification of road asphalt 90;

4) The development of this product has a good market prospect and it is also an environmental protection, energy conservation, waste comprehensive utilization project.
Raw materials
Waste tire rubber powder
Fortifier
Oily adhesive

Modification Mechanism of Asphalt by Rubber Powder
The interaction between rubber powder and asphalt is very complicated. Due to the differences in molecular weight and chemical structure, it caused the thermodynamic instability of the two when blended, and the effect of rubber powder modified asphalt is greatly affected. However, the current interaction mechanism between rubber powder and asphalt has not been studied clearly, and no unified conclusion has been formed. The theory combined with domestic and foreign research results are following:

The Theory of Physical Blending. The molecules of rubber powder swell and dissolve under the action of aromatic and saturated components of asphalt, and then evenly disperse in asphalt to form a blending system after the rubber powder is added to the asphalt. No chemical reaction occurs in physical blending, only physical reaction.

The Theory of Net Filling. After the rubber powder is added to the asphalt, the rubber powder molecules are separated by the oil and aromatic components in the asphalt, and swelling and partial dissolution occur. Then it is the dispersion process of diffusing and swelling the colloidal particles so that the rubber powder is randomly distributed in the asphalt matrix in the form of particles or filaments.

The Theory of Chemical Blending. Asphalt contains not only paraffinic, olefinic and aromatic hydrocarbons, but also polar and non-polar compounds besides organic functional groups such as hydroxyl and aliphatic groups. It can chemically react with many substances, producing chemical crosslinks or chemical additions and forming new chemical bond combinations. Adding a vulcanizing agent to the waste rubber powder modified asphalt causes the rubber to undergo a vulcanization reaction, which can form a vulcanized macromolecular network structure.

The Theory of Swelling Degradation. Rubber powder swelling in asphalt at lower temperature while the cross-linking network between rubber molecules is broken occurring desulfurization and degradation reactions at higher temperatures. The microscopic interaction mechanism between the rubber powder and asphalt mentioned in these several theories may often exist in the process of blending just different in degree. The mechanism mentioned in these theories may be closely related to factors such as the type of asphalt, the composition and particle size of rubber powder, the type and content of admixtures, and the preparation process conditions of binder systems.

Preparation Principle of Liquid Waste Rubber Asphalt Modifier
The preparation is divided into two sections:
1) Preparation of liquid recycled rubber liquid.
2) Liquid recycled rubber fluid modification.

The preparation of liquid recycled rubber liquid: The two-way reaction method of physical decomposition of waste rubber at low temperature and atmospheric pressure and the physical decomposition of adding softener to make waste rubber fully soften and swell is carried out at the same time. The two-phase reaction of physical change and chemical change is carried out at the same time to achieve the purpose of producing liquid regenerated rubber. This process is a strong swelling physical reaction and redox reaction. In the two-phase reaction, the swelling method is to use softener to make the waste rubber powder swell at proper temperature. The molecules of the solute (gum powder) and the solvent (softener) diffuse into each other, forming a saturated equilibrium phase of melting by intense agitation process so that it solve the phenomenon of easy precipitation and modification of domestic rubber powder modification.
Chemical decomposition at low temperature and atmospheric pressure: The special desulfurizer was used for redox reaction to make S=S and C=C in waste rubber molecules broken into new substances with similar molecular weight to asphalt. Under acidic conditions, saturated hydrocarbons are dehydrogenated to form unsaturated hydrocarbons so as to prepare the reaction conditions for the next grafting polymerization.

This experiment combines physical and chemical changes. There are many physical changes in chemical reactions and chemical changes in physical changes so that chemical changes are supported by physical changes and physical changes require greater support for chemical changes. The idea of this experiment is to shorten the reaction time and add more and faster new substances, obtaining a liquid recycled rubber liquid intermediate.

Liquid recycled rubber fluid modification: The tackifier was added for grafting and viscosification in the rubber liquid containing carboxyl and hydroxyl groups, increasing the flexibility of the waste rubber liquid, the brightness and high viscosity. Tackifier is selected as long-chain tackifier, suitable for dispersion, compatible and miscible. It breaks into the original macromolecular body by breaking into the original waste rubber liquid, forming a new substance close to the molecular weight of the asphalt, and forming a colloid with the same new charge.

**Take the Preparation Process**

Chemical reactions of substances include liquid-liquid phase, gas-vapor phase, gas-liquid phase, gas-solid phase, and liquid-solid phase reaction. Adopting liquid solid phase reaction, the waste rubber powder is the solid phase, the softener and the oil-soluble (water-soluble emulsifier) viscosifier are all liquid phase so that the liquid and solid phase can form liquid - liquid phase substance through physical and chemical methods and they will not appear solid-liquid separation.

![Figure 1. Process flow chart.](image)

**Conclusion**

The preparation of modified asphalt by mixing liquid waste rubber asphalt modifier and matrix asphalt is a technological revolution in the production mode of waste rubber powder modified asphalt, which breaks through the processing technology of traditional rubber powder modified asphalt and opens up a new production way. The modified asphalt produced by this method with good stability is not easy to be isolated and can be directly transported by automobile, stored by irrigation, mixed and paved within a radius of 300-400 kilometers without secondary heating which can reduce the paving cost, accelerate the paving speed, improve the paving quality and extend the service life of the pavement. Therefore, the research of liquid waste rubber asphalt modifier has significant economic, social benefits and broad application prospects.

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