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The Rheological Properties of Recycled Asphalt With Pyrolysis Oil From Waste Plastics

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Abstract

To understand the regeneration effects of PEO and PPO regenerants on aged asphalt, this chapter studies the physical properties of the regenerated asphalt and finds that PEO and PPO can basically restore the performance of aged asphalt, but the improvement effects of PEO and PPO on base asphalt and SBS modified asphalt are different.

Keywords

Waste Plastic Pyrolysis Oil; Regenerant; Rheological Properties

1. Preparation and Test Methods of Recycled Asphalt from Waste Plastic Pyrolysis Oil

1.1. Raw materials

Tab.1. 1 Basic technical indicators of original asphalt

Technical indicators	70# unaltered asphalt	SBS modified asphalt	PAV 70# base asphalt	PAV SBS modified asphalt
Penetration	62	53	18.5	13.3
Softening point	49	70.5	64	82
ductility	113.2	50.5	1.6	0.9

1.2. Preparation of recycled asphalt

Different PAV-aged asphalts were heated to (140 ± 5) ℃ until they became fluid. Then, different dosages of waste plastic oil regenerants (PEO, PPO) were added and mixed with them. The mixture was sheared at a shear rate of 3000 r/min for 20 minutes at (140 ± 5) ℃ to produce waste plastic oil-regenerated asphalts with different contents. Initially, the dosages of each waste plastic oil regenerant were set

at 4%, 6%, and 8% of the mass of the aged asphalt, respectively.

2. Physical Properties of Recycled Asphalt from Waste Plastic Pyrolysis Oil

2.1. Penetration

Penetration is one of the important indicators for evaluating the performance of asphalt. The smaller the penetration, the thicker the asphalt. Figure 1.1 shows the test results of the penetration of various recycled asphalts at 25℃. It can be seen from the figure that after aging, the penetration of 70# base asphalt and SBS modified asphalt decreased by 70.16% and 74.91% respectively. The addition of plastic oil regenerant can significantly increase the penetration of aged asphalt. For every 2% increase in the dosage of PEO regenerant, the penetration of recycled 70# base asphalt and SBS modified asphalt increased by an average of approximately 15.54% and 15.47% respectively. For every 2% increase in the dosage of PPO regenerant, the penetration of recycled 70# base asphalt and SBS modified asphalt increased by an average of approximately 22.55% and 18.86% respectively. This indicates that PPO has a better effect on restoring the penetration of aged asphalt, which may be because PPO has a higher content of aliphatic hydrocarbons and aromatics, and these two substances can soften aged asphalt [48], thereby increasing its penetration.

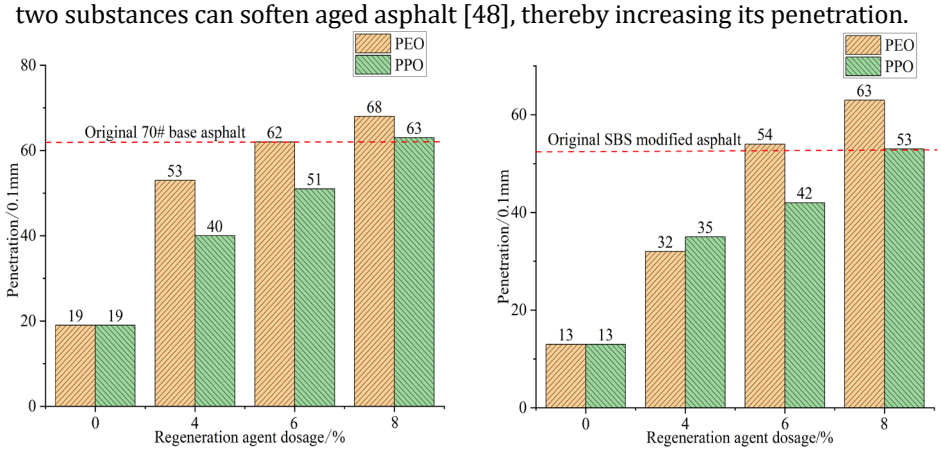

Fig.1. 1 Test results of penetration of different rejuvenated asphalt

When the dosage of PEO regenerant is 6% and that of PPO regenerant is 8%, the penetration of the recycled asphalt can basically be restored to the original level. When the dosage of PEO is 6%, the penetration of recycled 70# base asphalt and SBS modified asphalt differs from that of the original asphalt by 0.48% and 2.45% respectively; when the dosage of PPO is 8%, the penetration of recycled 70# base asphalt and SBS modified asphalt differs from that of the original asphalt by 0.81% and 0.38% respectively.

2.2. Softening Point

Figure 1.2 shows the test results of the softening point of each recycled asphalt. It can be seen from Figure 1.2 that after aging, the softening points of 70# base asphalt and SBS modified asphalt increased by 30.61% and 16.31% respectively, with an increase of more than 10℃. The higher the softening point of the asphalt, the better its high-temperature performance. This indicates that the aged asphalt has better high-temperature performance. The addition of PEO and PPO regenerants can effectively reduce the softening point of aged asphalt. When the dosage of PEO (PPO) regenerant increases by 2%, the softening points of recycled 70# base asphalt and SBS modified asphalt decrease by 6.53% and 6.79% (7.21% and 7.63%) respectively. When the dosage of PPO regenerant increases by 2%, the softening points of recycled 70# base asphalt and SBS modified asphalt decreases by 5.88% and 10.66% (2.52% and 3.00%) respectively. This indicates that the PEO regenerant has a better effect on restoring the anti-deformation performance and heat resistance of aged asphalt than the PPO regenerant.

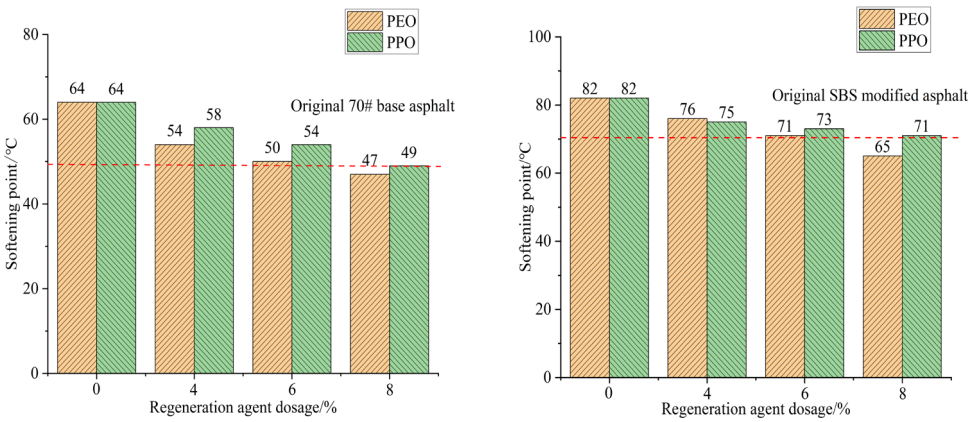

Fig.1. 2 Test results of softening points of different rejuvenated asphalt

When the dosage of PEO regenerant is 6% and that of PPO regenerant is 8%, the softening point of the recycled asphalt basically recovers to the level of the original asphalt. When the dosage of PEO regenerant is 6%, the softening points of recycled 70# base asphalt and SBS modified asphalt are 2.24% and 0.43% higher than those of the original asphalt respectively; when the dosage of PPO regenerant is 8%, the softening point of recycled 70# base asphalt is 0.82% lower than that of the original asphalt, while that of recycled SBS modified asphalt is 0.99% higher than that of the original asphalt. Due to the loss of light oil components and the change of colloid structure during the aging process of asphalt, the asphalt becomes harder and more brittle, thus increasing the softening point. However, the plastic oil contains chemical components similar to the saturated and aromatic fractions in the asphalt composition, which can replenish the light oil components of aged asphalt, improve its colloid structure, soften the aged asphalt, and reduce its softening point.

3. Ductility

Figure 1.3 shows the test results of the ductility of each recycled asphalt. It can be seen from the figure that as the dosage of PEO and PPO recycling agents increases, the ductility of the asphalt shows an upward trend. This is mainly because the aliphatic hydrocarbons and aromatics contained in the plastic oil can soften the aged asphalt and improve its ductility. For every 2% increase in the dosage of PEO (PPO) recycling agent, the ductility of recycled 70# base asphalt increases by 12.27% and 9.00% respectively, and the ductility of recycled SBS modified asphalt increases by 32.27% and 26.41% respectively. For every 2% increase in the dosage of PPO recycling agent, the ductility of recycled 70# base asphalt increases by 17.09% and 12.03% respectively, and the ductility of recycled SBS modified asphalt increases by 18.90% and 12.80% respectively. This indicates that PEO recycling agent has a better effect on restoring the ductility of aged base asphalt, while PPO recycling agent has a better effect on restoring the ductility of aged SBS modified asphalt.

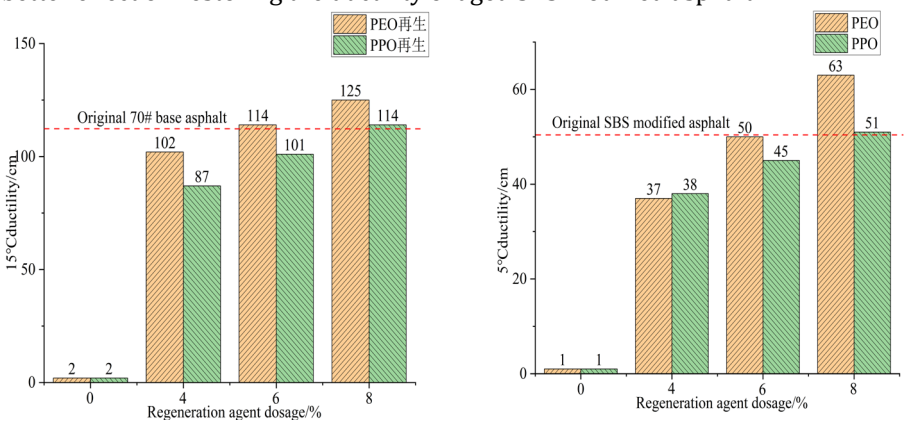

Fig.1. 3 Test results of ductility of different rejuvenated asphalt

When the dosage of PEO regenerant is 6% and that of PPO regenerant is 8%, the ductility of the two types of recycled asphalt can be restored to be basically the same as that of the original asphalt. When the dosage of PEO regenerant is 6%, the ductility of recycled 70# base asphalt and SBS modified asphalt differs from that of the original asphalt by 1.06% and 1.78% respectively; when the dosage of PPO regenerant is 8%, the ductility of recycled 70# base asphalt and SBS modified asphalt differs from that of the original asphalt by 0.35% and 1.19% respectively.

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