Winter 1-10-2017

Chemical-Rheological Evaluation of the Short-Term and Long-Term Effectiveness of Binder Rejuvenators

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Chemical-Rheological Evaluation of the Short-Term and Long-Term Effectiveness of Binder Rejuvenators

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INTRODUCTION

✓ Many previous studies have investigated how rejuvenators affect/alter mechanical/chemical characteristics of aged binders. However, it has not been actively examined how the rejuvenated binders will perform for the next round of service after the rejuvenation was made. A better understanding of the short-term and long-term effect of rejuvenating agents in RAP blended asphalt mixtures is necessary to achieve more appropriate selection and use of rejuvenating agents.

OBJECTIVE

✓ To identify and quantify the short-term and long-term influence of rejuvenators on the properties of binders.

MATERIALS

Table 1. Binders Used in This Study.

Binder	Binder ID
Virgin Original Binder (PG 64-28)	VO
RTFO of VO	RO
RTFO+PAV of VO	PO
Modified VO by a Rejuvenator 1 (Petroleum Technology)	VOR1
RTFO of VOR1	ROR1
RTFO+PAV of VOR1	POR1
Modified VO by a Rejuvenator 2 (Green Technology)	VOR2
RTFO of VOR2	ROR2
RTFO+PAV of VOR2	POR2

RESEARCH METHOD

Dynamic Shear Rheometer (DSR)

Fourier Transform Infrared Spectroscopy (FTIR)

Saturate-Aromatic-Resin-Asphaltene (SARA) Analyzer

RESULTS - DSR

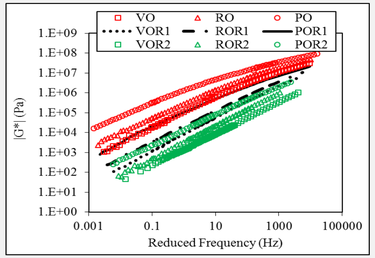

Fig. 1. Master curves of all Binders at a reference temperature of 25 ºC.

RESULTS - SARA

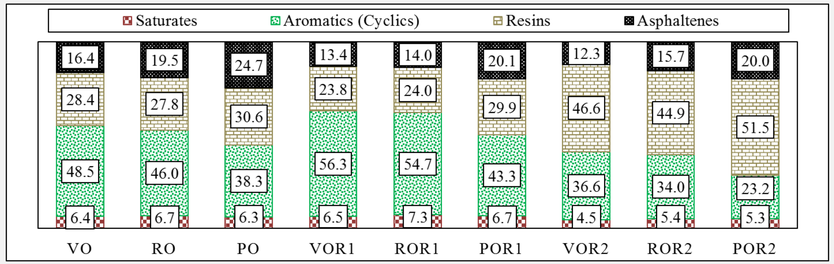

Fig. 2. SARA test results of binders.

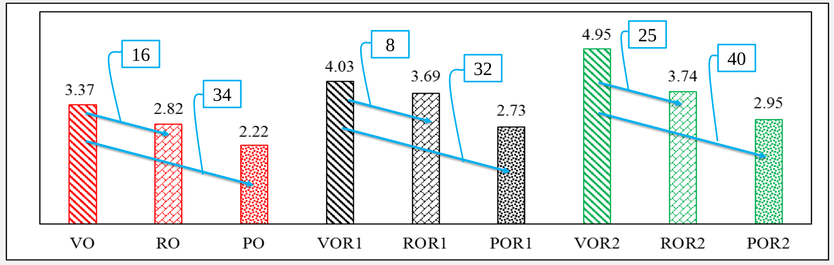

Fig. 3. Colloidal Instability Index (CII) of binders.

RESULTS - FTIR

Table 2. Structural Indices of Binders.

Binder ID	Carbonyl Index ($I_{C=O}$)	Sulfoxide Index ($I_{S=O}$)	Aliphatic Index (I_{Al})	Aromatic Index (I_{Ar})
VO	0.006	0.020	0.800	0.120
RO	0.011	0.030	0.791	0.116
PO	0.027	0.056	0.748	0.122
VOR1	0.005	0.010	0.768	0.153
ROR1	0.008	0.013	0.761	0.157
POR1	0.031	0.026	0.744	0.147
VOR2	0.377	0.008	0.515	0.091
ROR2	0.296	0.006	0.580	0.106
POR2	0.215	0.002	0.637	0.135

CONCLUSION

- The effects of rejuvenation were examined by inter-relationships between mechanical properties and chemical characteristics of the binders.
- Rheological test results from the DSR show that rejuvenators generally soften binders by providing lighter molecules (maltenes) into the binder, but due to different chemical compositions and interaction mechanisms involved, their effects on binders are different and becomes more different with further aging process.
- The SARA test results imply that the particular rejuvenators can react with binders quite differently.
- From the FTIR results, it appears that aliphatics are critical to maintain low viscous behavior in the binder. Rejuvenation helps preserving the chemical composition of the binder during aging.
- Based on the SARA and FTIR results from the two different rejuvenators subjected to different aging levels, it is implied that rejuvenation process of the aged binder is quite dependent on interactions between materials. This should be accounted for better selection and more proper use of rejuvenating agents.