Pacific Coast Conference on Asphalt Specifications
Committee on Asphalt

Study of the Effects of Pressure Aging Vessel (PAV) Tray Position on Rheologic Properties

Contents

Task Group

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20 November, 2006

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1.0 Introduction and Objectives.

Observations on characteristics of materials on different tray levels from the PAV after aging show a difference in color and texture. Questions arose concerning the possibility of differences in rheologic properties (complex shear modulus, G*, phase angle, δ, as measured by dynamic shear rheometer (DSR), "m" – value, and stiffness, S as measured with the bending beam rheometer (BBR)). If tray location does have a significant effect, it is possible that precision of results of DSR and BBR could be adversely affected and measures need to be taken to mitigate the effects.

A task group from the asphalt subcommittee was formed to develop an interlaboratory study (ILS) to evaluate the effects.

2.0 Results.

There is no significant effect due to tray location.

3.0 Design of Experiment.

3.1 Participating Laboratories:

Federal Highway Administration – Western Direct Lands, Vancouver, WA.
McCall Oil and Chemical, Portland, OR.
U.S. Oil and Refining Co., Tacoma, WA.
Washington DOT, Olympia, WA.

3.2 Materials:

PG 64-22.
PG 70-22.
PG 76-22PM (Polymer Modified).

3.3 Test Temperatures:

DSR: Appropriate for grade.
BBR: -12C.

3.4 Tray Locations: (see Figure 1)

Upper (Tray 1) labeled "U."
Middle (Tray 5) labeled "M."
Lower (Tray 10) labeled "L."

3.5 Test Sequence:

Stratified random.

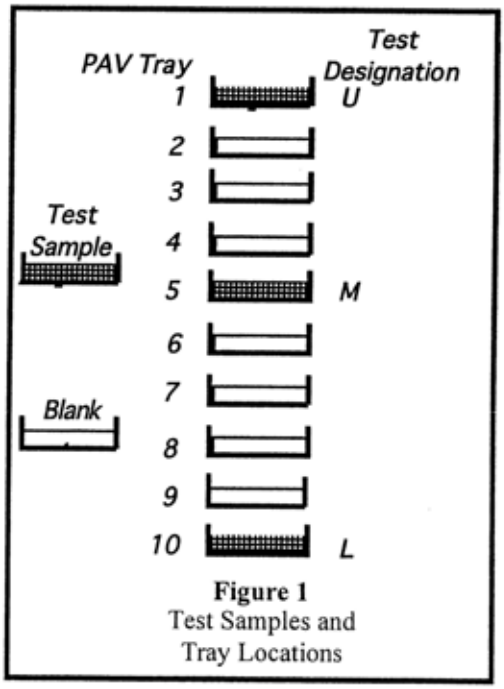

Figure 1
Test Samples and Tray Locations

4.0 Analysis.

4.1 Raw data is shown in Appendix A.

Data for each material is plotted with plus and minus two and three standard deviations in Appendix B. Intent of these plots is twofold: 1) examine data for outliers – no data points were declared to be outliers, and 2) allow each participant to compare results with other laboratories.

4.2 Analysis was aided by the SAS program, "JMP®" with graphics shown in Appendix C. Typically (see page C-1 of 28), an analysis of variance (ANOVA) table is shown along with a means comparison by the Tukey-Kramer HSD test. Non-intersecting circles on the right side of the graph represent significant differences in means whereas intersecting circles indicate no significant differences (see page C-9 of 28).

4.3 Materials effect is shown on pp. C-1 through C-4 of 28. Different grades show significantly different properties for both DSR and BBR.

4.4 Pages C-5 through C-8 show the strong possibility of a laboratory effect for all properties except G*. This is also reflected in he analysis for laboratory by material interaction (to follow).

4.5 In order to insure that each laboratory tested all materials at all tray locations in the PAV, materials and trays were stratified into groups (see Appendix A). Tests for effects of "group" and validity of the stratified random test sequence are shown on pp. C-9 through C-12. No significant effects were observed.

4.6 Pages C-13 through C-16 show the analysis for effect of tray location when all materials are included. No significant effects were observed. Pages C-17 through C-28 show the analysis for tray location for each material. Again, no significant effects were observed.

4.7 A summary of all analysis for main effects is shown in Table 1.

Table 1
Analysis Summary (Significant = "Sig," Not Significant = "NS")

Analysis	*Appx.*	*G**	*δ*	*"m"*	*S*
Material, All Data	*C-1 - C-4*	*Sig*	*Sig*	*Sig*	*Sig*
Laboratory, All Data	*C-5 - C-8*	*NS*	*Sig*	*Sig*	*Sig*
Group, All Data	*C-9 - C-12*	*NS*	*NS*	*NS*	*NS*
Tray Location, All Data	*C-13 - C-16*	*NS*	*NS*	*NS*	*NS*
Tray Location, Matl. A	*C-17 - C-20*	*NS*	*NS*	*NS*	*NS*
Tray Location, Matl. B	*C-21 - C-24*	*NS*	*NS*	*NS*	*NS*
Tray Location, Matl. C	*C-25 - C-28*	*NS*	*NS*	*NS*	*NS*

4.8 Material by Laboratory Interaction is shown in Appendix D. JMP output includes three graphics. First is a "Leverage Plot." The plot shows a solid regression line with dashed upper and lower limits and a dashed line for overall mean. For cases of strong interaction, the lower dashed limit crosses the mean. A second graphic, "Interaction Profile" plots values for the property (G*, etc.) vs. material and laboratory. Crossing lines show interactions. Finally, an analysis of variance (ANOVA) table is shown as "Effects Tests." Probability ("Prob >F) less than about 0.05 indicates a significant effect.

For all properties, material and laboratory are significant (Prob > f < 0.001). This is verified by the analysis discussed in Sections 4.3 and 4.4. While not particularly strong, δ and m show the possibility of an

interaction (Prob >F 0.0539 and 0.0678) and crossing lines on the Interaction Profile verify the possibility.

Given that the possibility of an interaction exists, as was the case for the Interlaboratory Study on DSR under way by the asphalt committee, it would be interesting to discuss the testing program between the four participants to determine the possibility of different interpretation of the test method or use of different methods for other reasons.

4.9 Effect of type of PAV device was considered with analyses shown in Appendix E. Two laboratories used the ATS PAV device and two used the Printex. Significant or marginal effects were found for all properties except "m" for about 38 percent of the tests. Results are shown in Table 2.

Table 2
PAV Type Summary (Significant = "Sig," Not Significant = "NS")

Analysis	Appx.	G*	δ	"m"	S
Type, All Materials	E-1 - E-4	NS	Sig	NS	NS
Type, Material A	E-5 - E-8	Sig	NS	NS	NS
Type, Material B	E-9 - E-12	Sig	Marginal	NS	NS
Type, Material C	E-13 - E-16	NS	Sig	NS	Marginal

As part of the analysis a routine check of equality of variance (statistical "homoscedasticity") showed variability to be greater for the ATS device in three or about 20 percent of the tests. Results are shown in Table 3.

Table 3
PAV Type Variability (Significant = "Sig," Not Significant = "NS")
For All Significant Cases, ATS Variability > Printex

Analysis	Appx.	G*	δ	"m"	S
Type, All Materials	E-1 - E-4	NS	NS	NS	NS
Type, Material A	E-5 - E-8	NS	Sig	NS	NS
Type, Material B	E-9 - E-12	NS	NS	Sig	NS
Type, Material C	E-13 - E-16	NS	Sig	NS	NS

A review of the possibility of PAV type by material interaction showed no significant effects.

It is suggested that consideration be given to discussions regarding type of PAV to determine if appropriate adjustments or modification of procedures are necessary to reduce the source of variability.

End