Reclaimed Asphalt Pavement Mixing and Compatibility

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Approach

- **Alternative methods for determining the degree of mixing found in asphalt-RAP mixtures**

- **Determining compatibility of asphalt-RAP mixtures**

Materials

- **RAP samples and materials from 4 different sources**
  - **Iowa**
  - **Palm Dale, CA**
  - **South Carolina**
  - **Manitoba:**
    - **RAP**
    - **2 binders; 150/200 and 200/300**
    - **15% RAP + 150/200**
    - **50% RAP + 200/300**
    - **50% RAP + 150/200**

RAP Mixing

- **Solvent extraction study combined with characterization**
  - **Toluene/EtOH vs. Cyclohexane**
    - **Cyclohexane ~ solvent characteristics of asphalt while tol-eth is a much stronger solvent system**
- **Characterization**
  - **% Recovered**
  - **Compositional – chromatographic characterization**
  - **Rheological**

RAP Mixing

- **Does initial mixing of RAP and virgin aggregate occur with any selectivity in the mix plant?**
- **Do the RAP aggregates and the virgin aggregates end up as different materials at high RAP concentration?**
  - **Physical study with additional characterization similar to solvent extract study.**
- **How does this affect material performance?????**

Compatibility

- **Automated Flocculation Titrimetry**
  - **Colloidal stability ~ Rheological properties**
  - **Heithaus Solubility Parameters**
    - **The mixing of RAP and Virgin binders will have profound affects on the colloidal stability of the virgin binder at high RAP concentrations.**

- **Automated testing for performance prediction**
  - **Many RAP stockpiles can be applied to mix design using the well known blending chart approach.**
    - **What has happened when the blends turn out much too soft or, even worse, much too stiff?**

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Compatibility - Blending

		Neat			TFOT + PAV, 60°C, 144 hours		
Mix #	Components of Mixture	Vis., Pa•s 25°C, 1 r/s	Tan ∂ 25°C, 1 r/s	R. S. Visc. 25°C, 1 r/s	Vis., Pa•s 25°C, 1 r/s	Tan ∂ 25°C, 1 r/s	Aging Index 60°C, 1 r/s
I (A)	AAD Maltenes (79%) AAD Asphaltenes (21%)	49,011	3.2	705	550,650	1.5	15.4
VII (B)	AAG Maltenes (94%) AAG Asphaltenes (6%)	389,100	6.3	64	1,086,400	1.6	4.2
	Cross Blends						
V (C)	AAG Maltenes (79%) AAD Asphaltenes (21%)	4,970,900	1.5	287 (?)*	20,662,000	0.8	15.5
III (A) (C)	AAD Maltenes (79%) AAG Asphaltenes (21%)	62, 908	3.7	906	552,310	1.8	9.0
II (D)	AAD Maltenes (94%) AAG Asphaltenes (6%)	1,023	>10	35	7,108	<10	3.7
VI (B) (D)	AAG Maltenes (94%) AAD Asphaltenes (6%)	337,190	6.0	54	2,125,400	2.3	5.3

Data from: "Fundamental Properties of Asphalts and Modified Asphalts", Vol. 1: Interpretive Report FHWA-RD-99-212, Oct. 2001.

(JCP, 09/08)

*Value is suspect. Reduced specific viscosity at 60°C is reported as 393.

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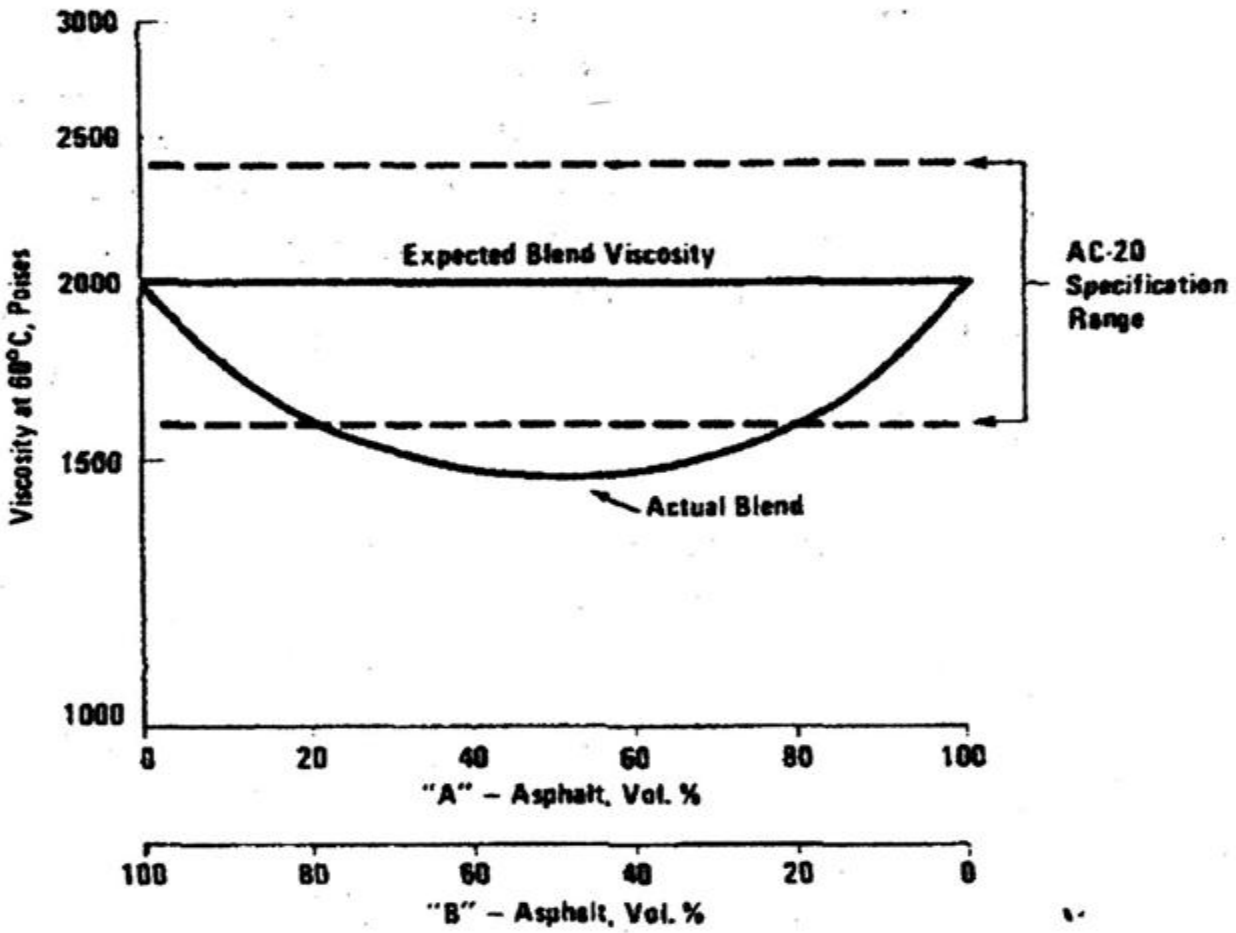
Compatibility – Blending



Reference: W. J. Kari. "Effects of Construction Practices on the Asphalt Properties in the Mix", *Proc. Canadian Tech. Asphalt Assn.*, vol. XXVII (1982), pp. 321-334. (cited in AAPT, Anderson, Petersen and Christensen, v. 55 (1986), pp. 250-268.

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Compatibility as Asphalt Ages

Sample ID		AFT Parameter Data			Wiehe Blending Numbers	
		P_a	P_o	P	δ_{floc}	δ_{oil}
Virgin Binder	**70-22**	0.70	0.75	2.5	7.5	8.4
Aged Binder		0.6	0.76	1.9	7.7	8.3
Virgin Binder 1		0.73	0.81	3.0	7.4	8.2
Virgin Binder 2		0.73	0.81	3.0	7.4	8.2
Blended Binders 50/50		0.78	0.87	3.9	7.3	9.4

Compatibility and Blending

- **Blending of characterized RAP and virgin asphalts to determine effects of mixing.**
  - **BI0001 and BI0002 (Venezuelan and San Juaquin)**
  - **Use of AFT as a tool for material selection in respect to compatibility/colloidal stability**
  - **Compositional (AFT, AD/WD, SARA) and rheological analyses will be used to further characterize the changes in material properties as a result of blending**

Progress

- **Solvent extraction and material comparison studies underway**
  - **Delay due to sample backlog as a result of major downtime while acquiring/installing new rheometers.**
- **AFT testing of virgin binder and Manitoba RAP mixtures underway**
- **Results from testing of unexpected asphalt softening in Oregon….some additional samples ☺**

Oregon Project

- **Samples supplied by Prof. Todd Sholz at Oregon St.**
  - **Virgin binder samples from two different projects on US-20 (70-22) and I-5 (70-28)**
    - **RAP modified (extracted at WRI)**
    - **RAP/RAS modified (extracted at WRI)**
  - **FTIR for excess solvent in extracted materials (extracted by ODOT or OSU)**
  - **AFT testing to determine a change in compatibility when reclaimed asphalt was blended.**

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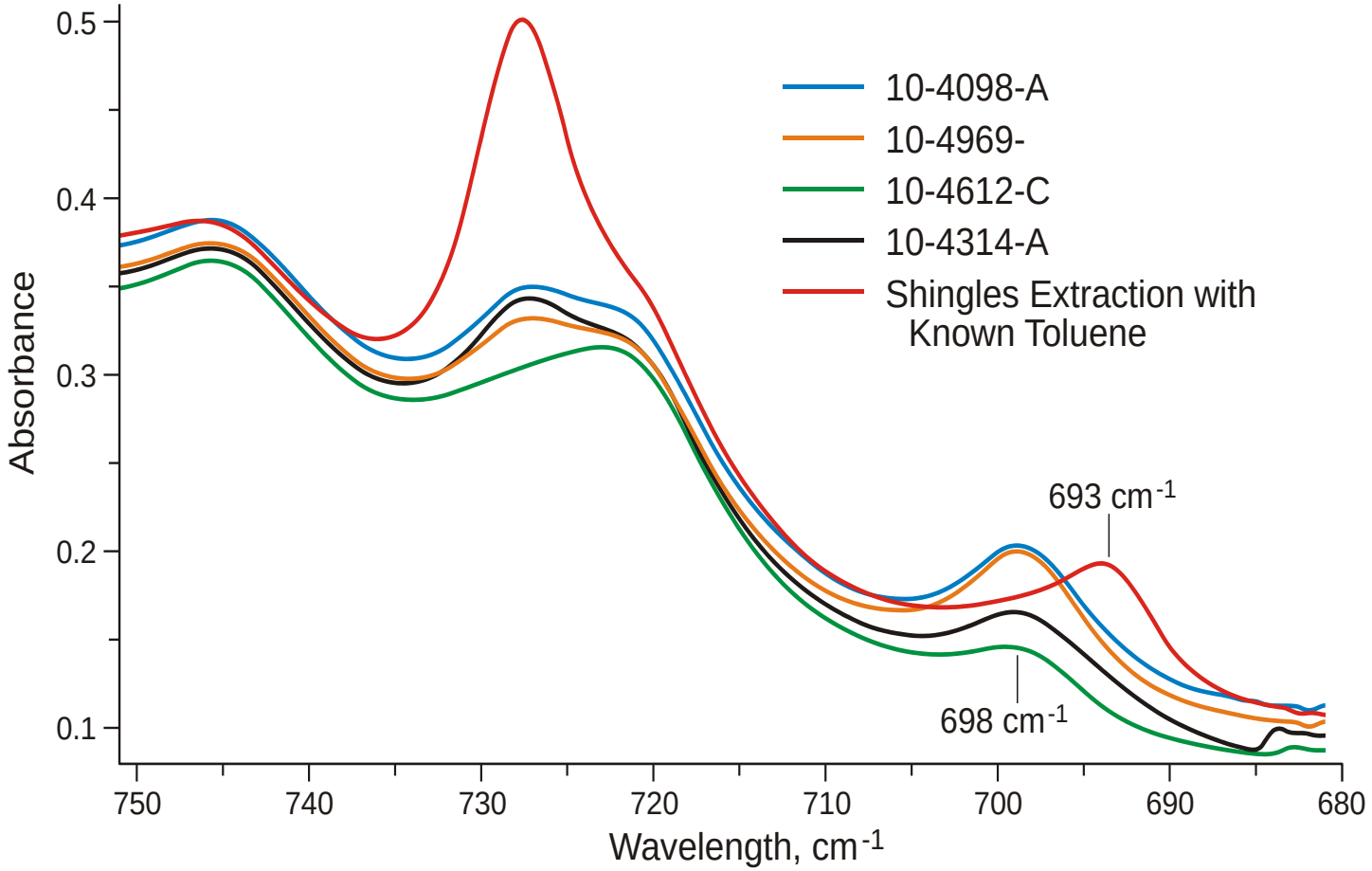
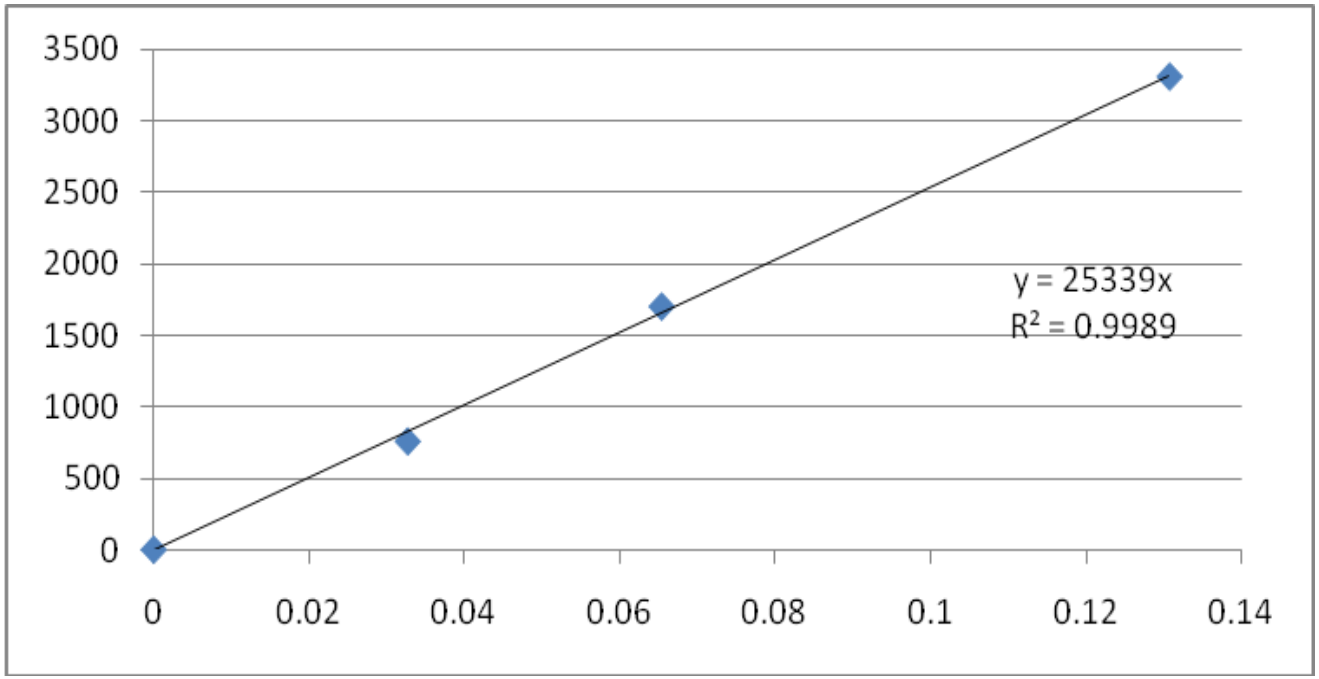
FTIR for Toluene



GCMS for Toluene



x axis	y axis
Toluene Conc mg/mL	m/z 91 Area
0	0
0.03266	757
0.06532	1699
0.13064	3306

Toluene in Sample Calculation:
0.059% wgt/wgt

590 ppm

1:19 molecules

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Oregon Data

Sample ID	AFT Parameter Data			Wiehe Blending Numbers	
	P_a	P_o	P	δ_{floc}	δ_{oil}
I-5					
70-22	0.70	0.75	2.5	7.5	8.4
70-22 RAP	0.64	1.2	3.3	7.6	9.3
70-22 RAP+RAS	0.62	1.5	3.9	7.6	9.3
US-20					
70-28	0.73	0.81	3.0	7.4	8.2
70-28 RAP	0.63	1.0	2.8	7.4	8.5
70-28 RAP+RAS	0.63	1.3	3.4	7.6	9.4

- **Compositional data still needed for correlation**