

# *Replacing the RTFO*



## Development of a New Short-Term Aging Apparatus

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# *Introduction*



- We were not satisfied with the RTFO
- Attempts to correct it only added complication
- Time to go back to the drawing board

# *Problems with RTFO*

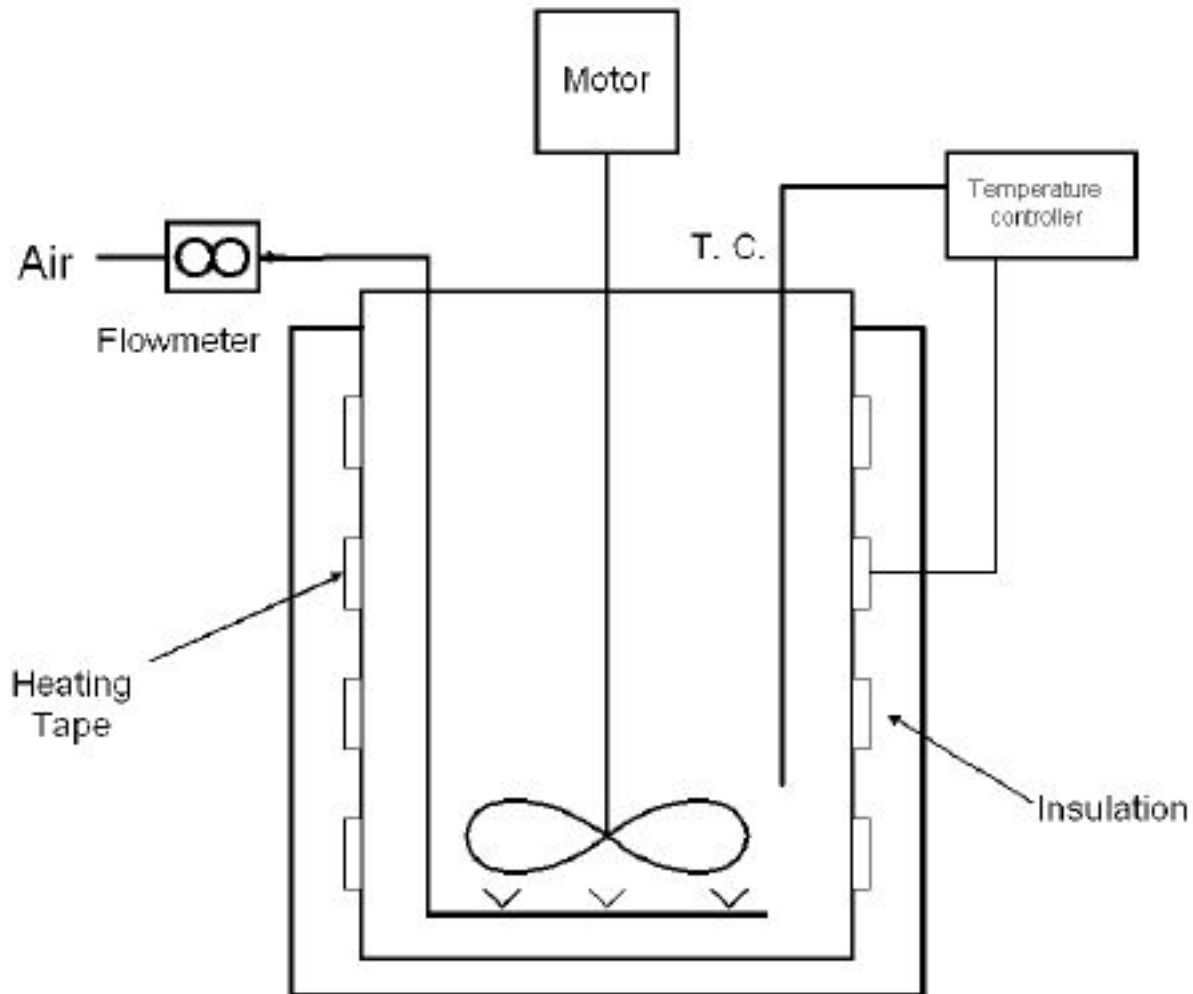


- Modified binder troubles
- Mass change and associated processes
- Sample size
- Mess/cleanup
- Burn hazards

# *Research Project 0-1742*



- Awarded to TTI in Sept 1999
- Looked at three methodologies
  - Microwave
  - Very thin film
  - Air blowing
- We chose to pursue air blowing

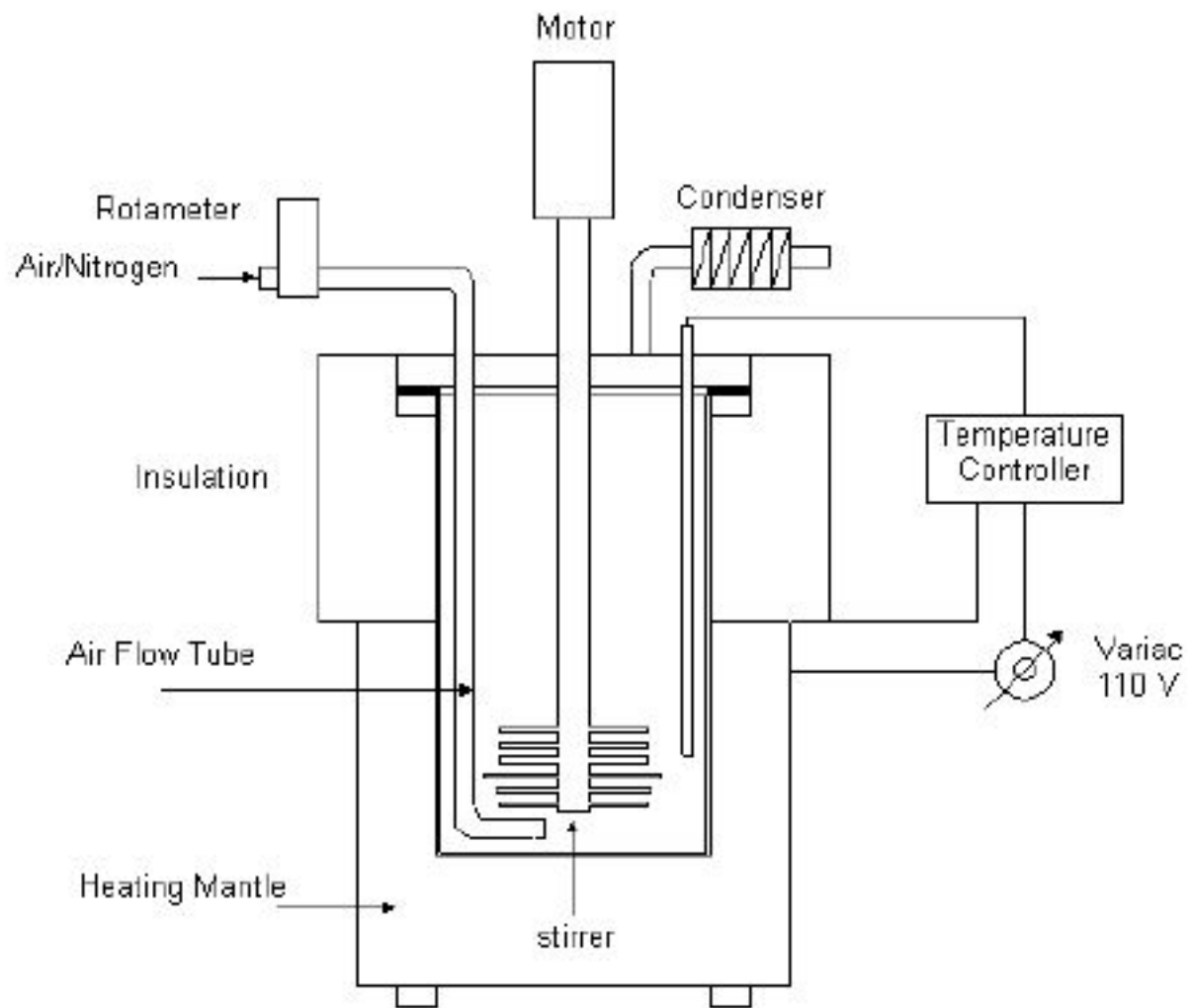


**Figure 2-1. Laboratory Unit Used for Air-Blowing Experiments.**

# *Design Aspects*



- Sample size
- Sample container
  - Size
  - Type (permanent/removable/disposable)
- Method of air introduction
  - distributed
  - single pipe
- Impeller type



**Figure 3-1. SAFT Apparatus.**

# *Property Comparisons*

- Compared key chemical and physical parameters for RTFO and SAFT materials
- Aging was chemically similar to RTFO
- Aging was physically similar, provided time was adjusted



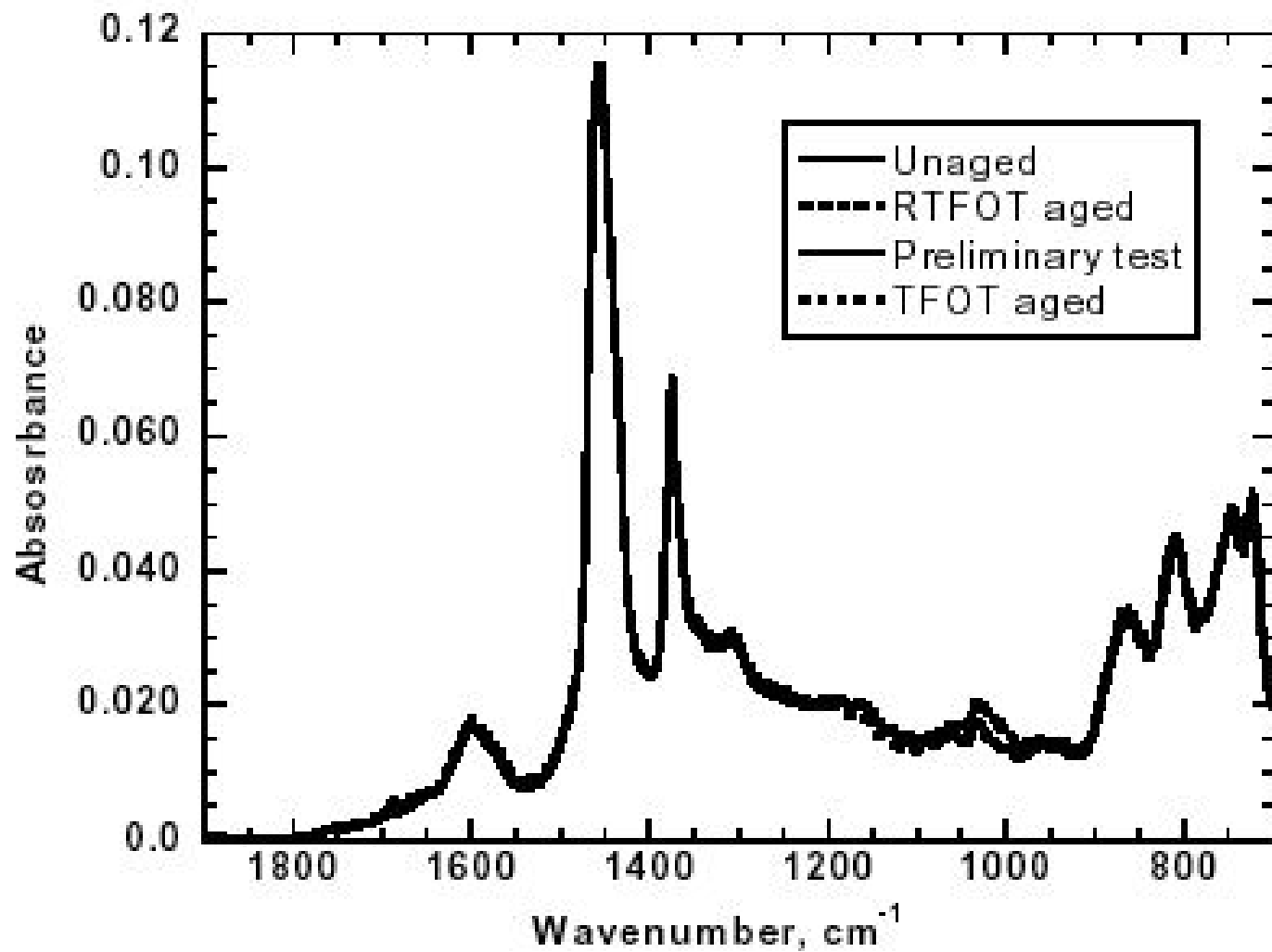
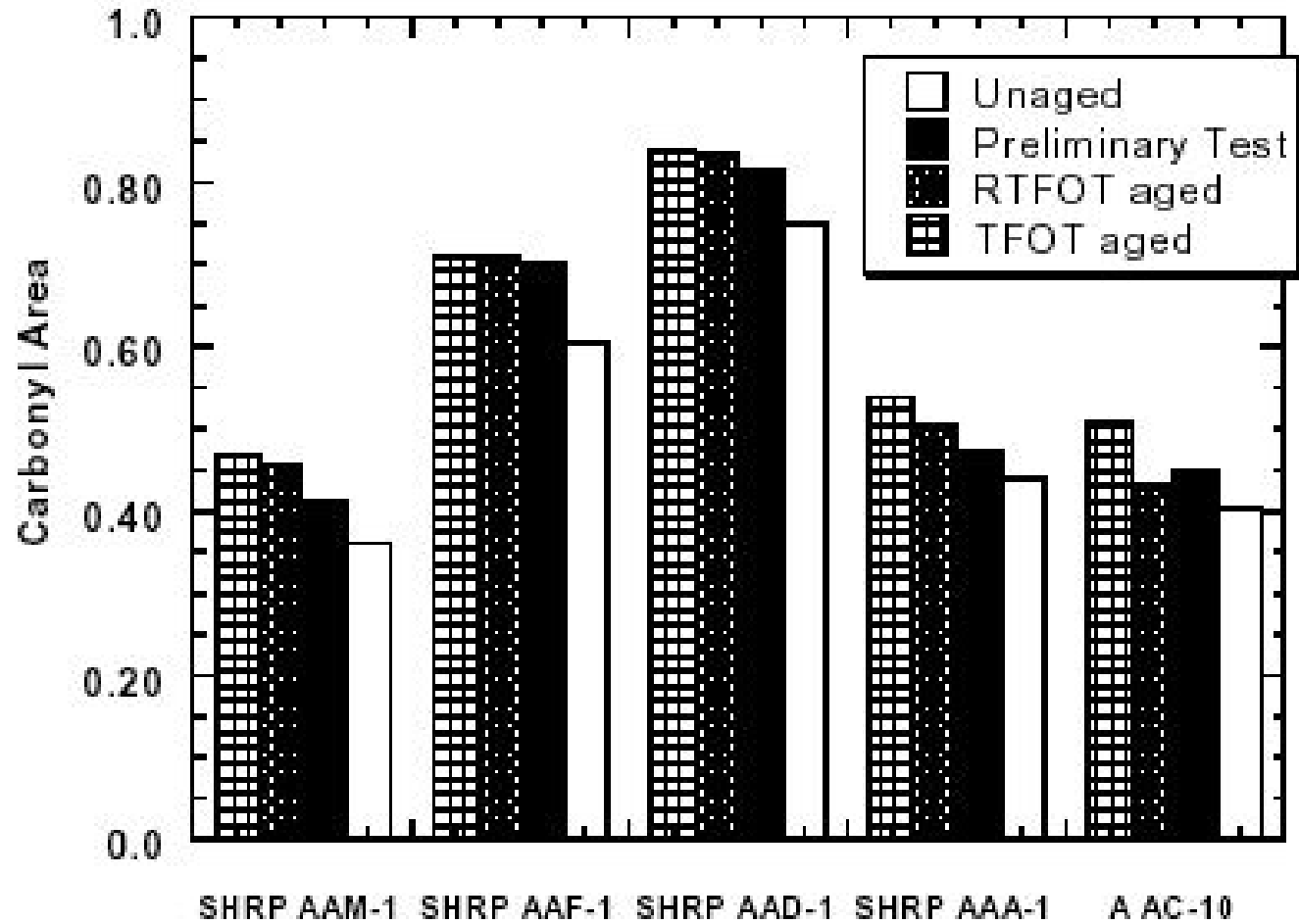
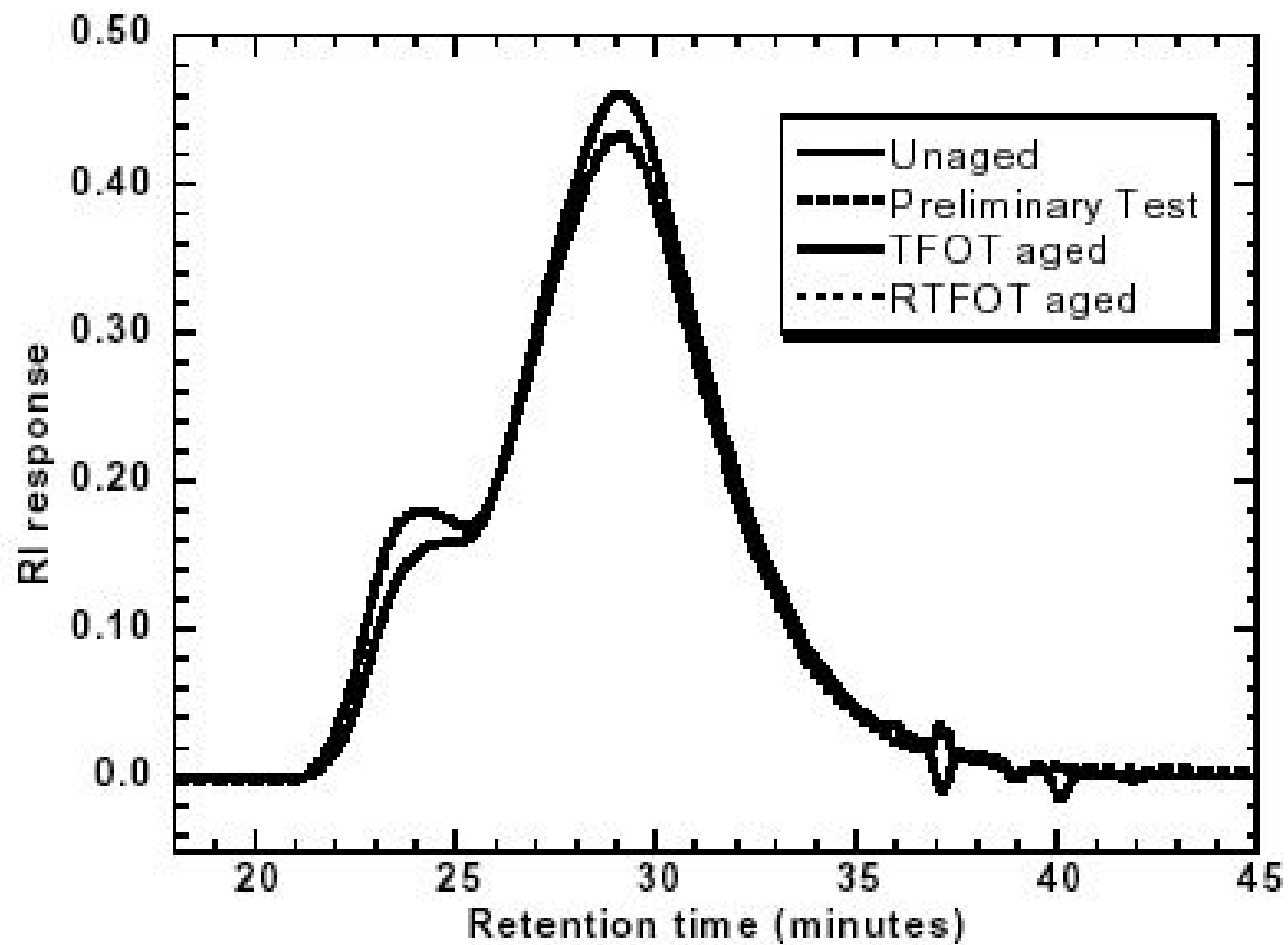


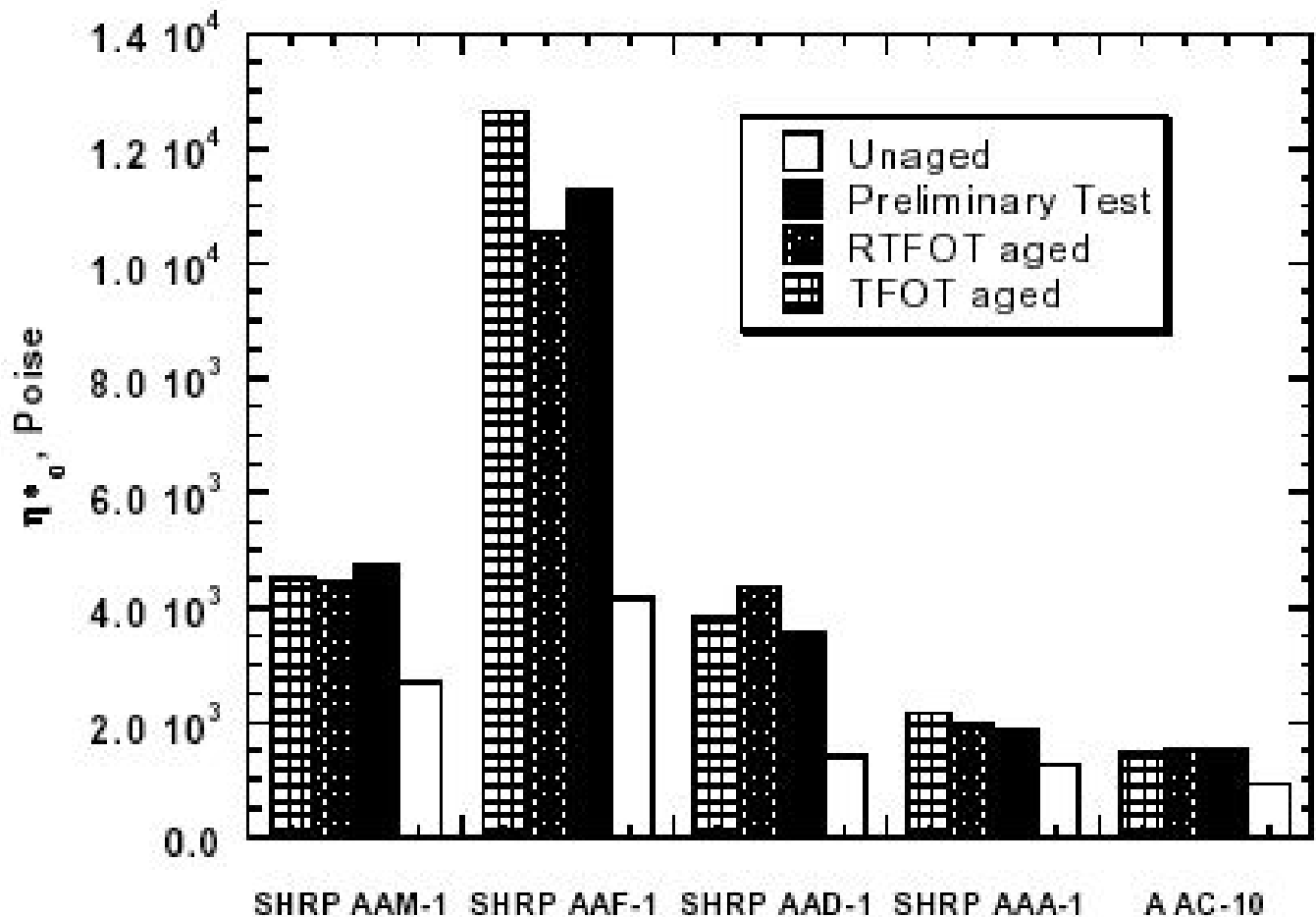
Figure 3-2. IR Spectra of Unaged and Aged A AC-10.



**Figure 3-3. Carbonyl Area of Unaged and Aged Asphalts.**



**Figure 3-8. GPC Spectra of Unaged and Aged A AC-10.**



**Figure 3-4. Limiting Complex Viscosity at 60 °C and 0.1 rad/sec of Aged and Unaged Asphalts.**

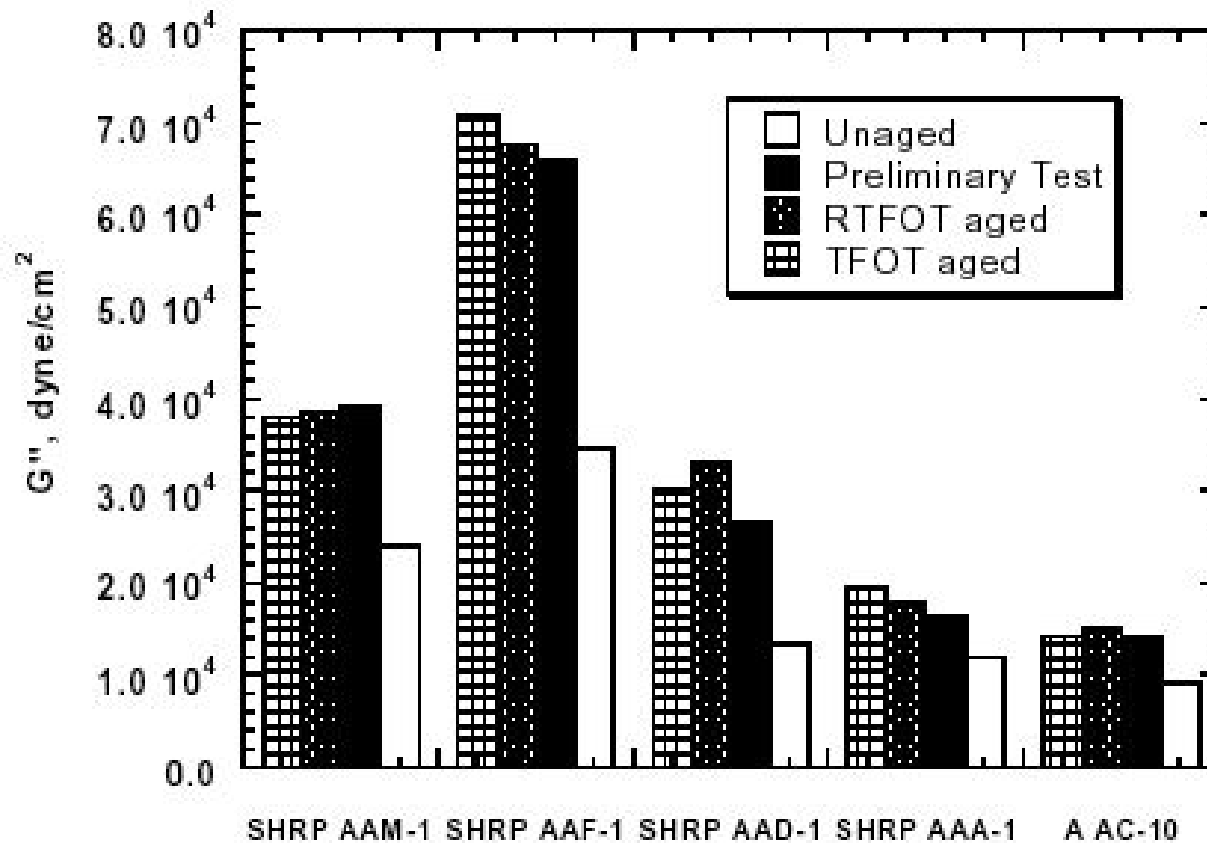
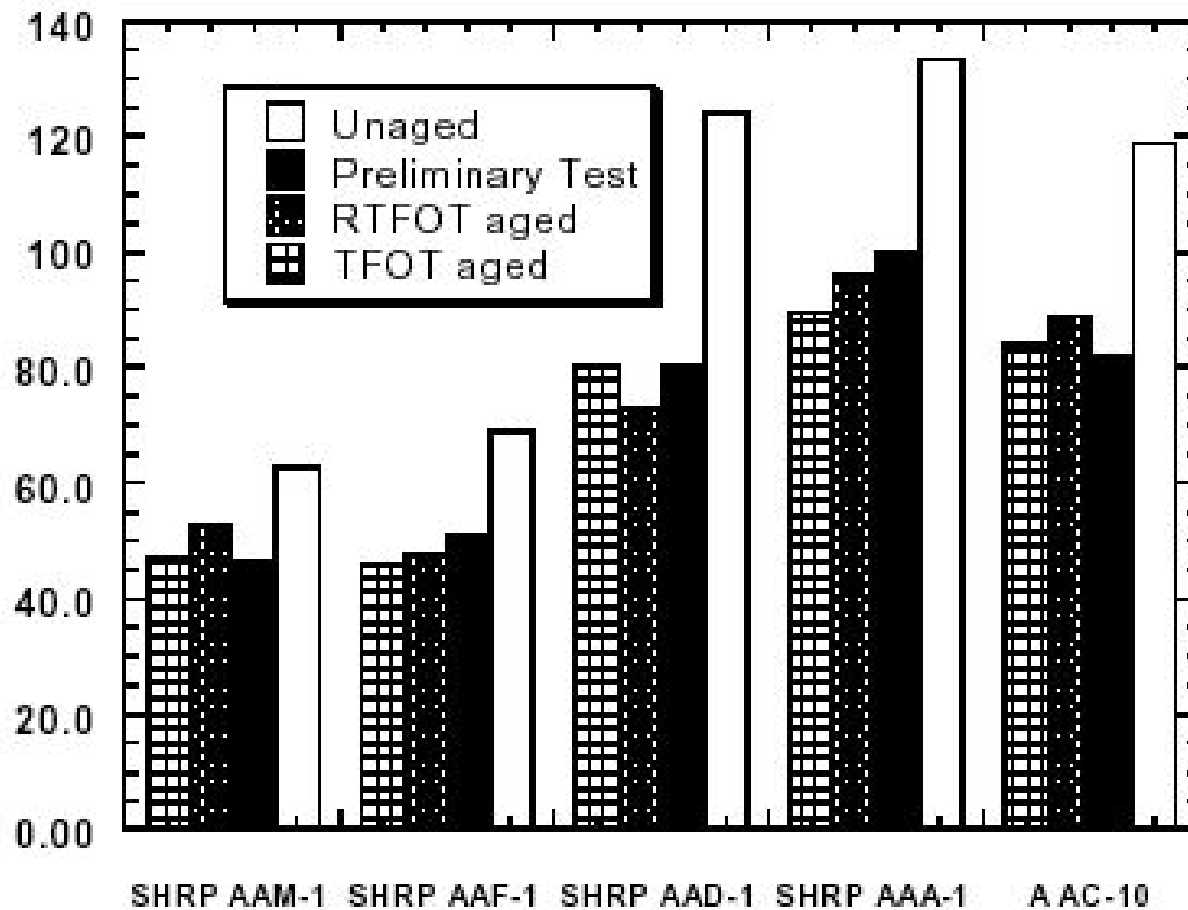
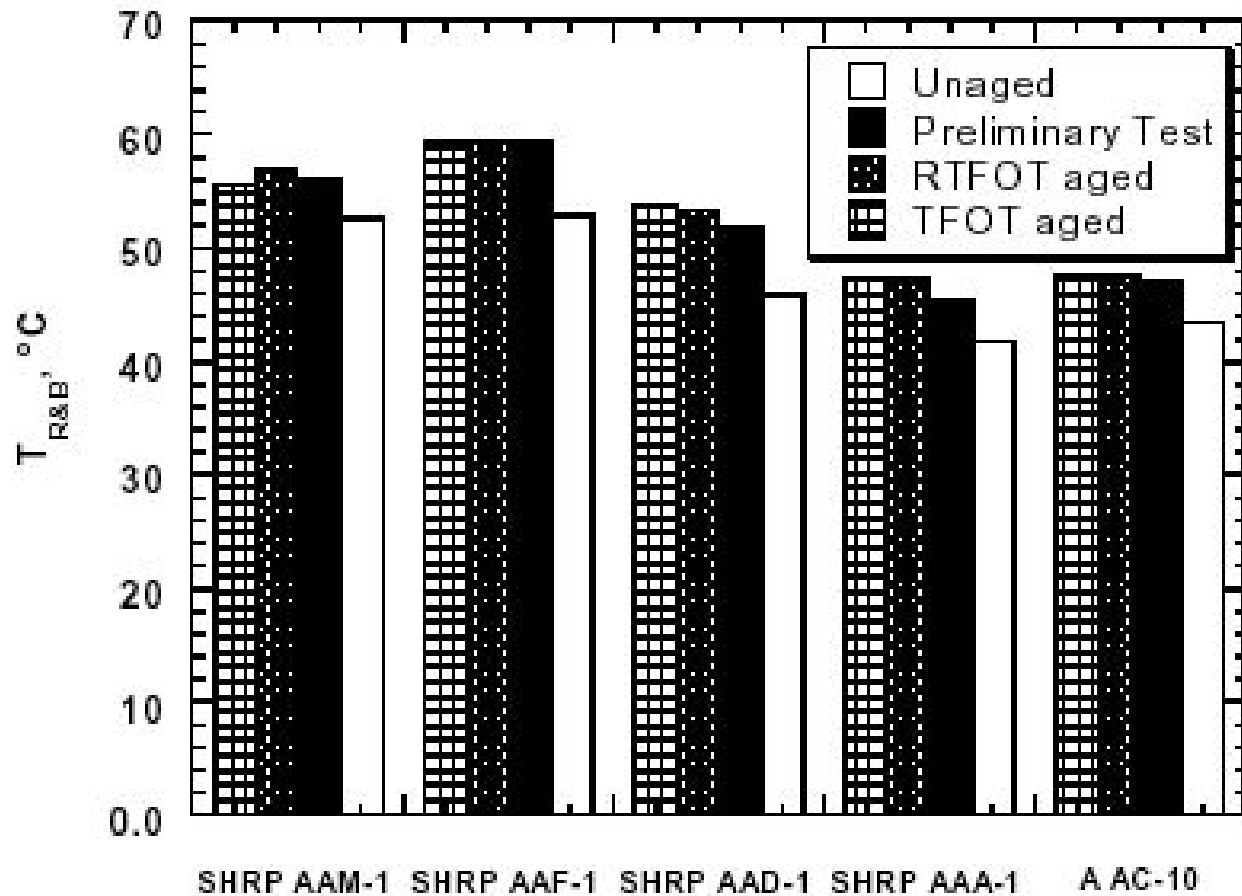


Figure 3-5. Loss Modulus  $G''$  at 60 °C and 10 rad/sec of Aged and Unaged Asphalts.



**Figure 3-6. Penetration at 25 °C of Aged and Unaged Asphalts.**



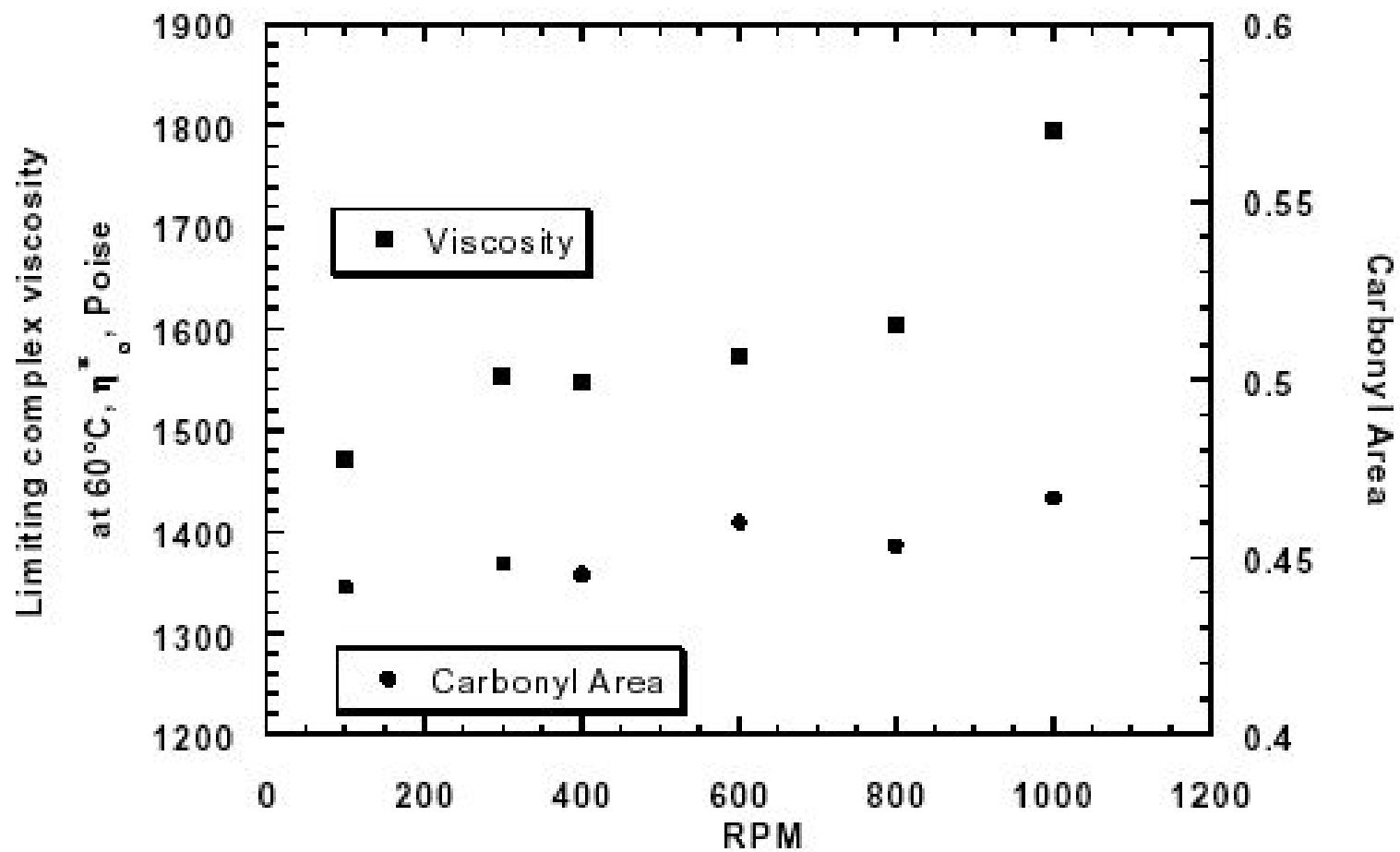
**Figure 3-7. Softening Point ( $T_{R\&B}$ ) of Aged and Unaged Asphalts.**

# *Test Parameters*

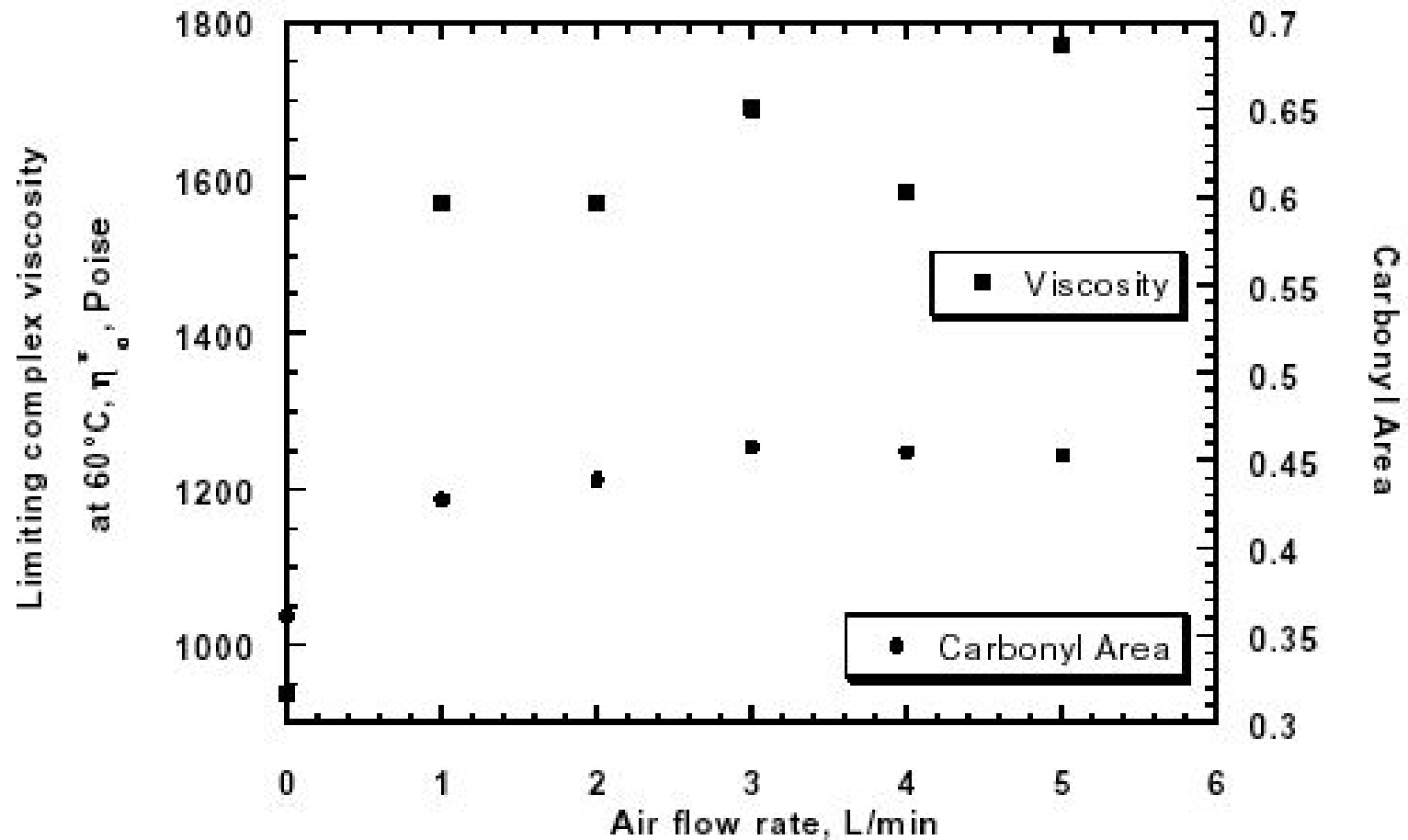


- Test temperature = 325°F
- Stirring rate
- Air flow rate
- Aging time - to be determined by properties
- Use of nitrogen





**Figure 3-11. Effect of RPM on Limiting Complex Viscosity and Carbonyl Area, Prototype Apparatus.**



**Figure 3-10. Effect of Air Flow Rate on Limiting Complex Viscosity and Carbonyl Area, Prototype Apparatus.**

# *Final Test Parameters*



- Temperature - 325°F
- Air Flow Rate - 2 L/min
- Stirring Rate - 700 RPM
- Sample Size - 250 g
- Aging Time - 30 min
- Nitrogen flow before and after aging

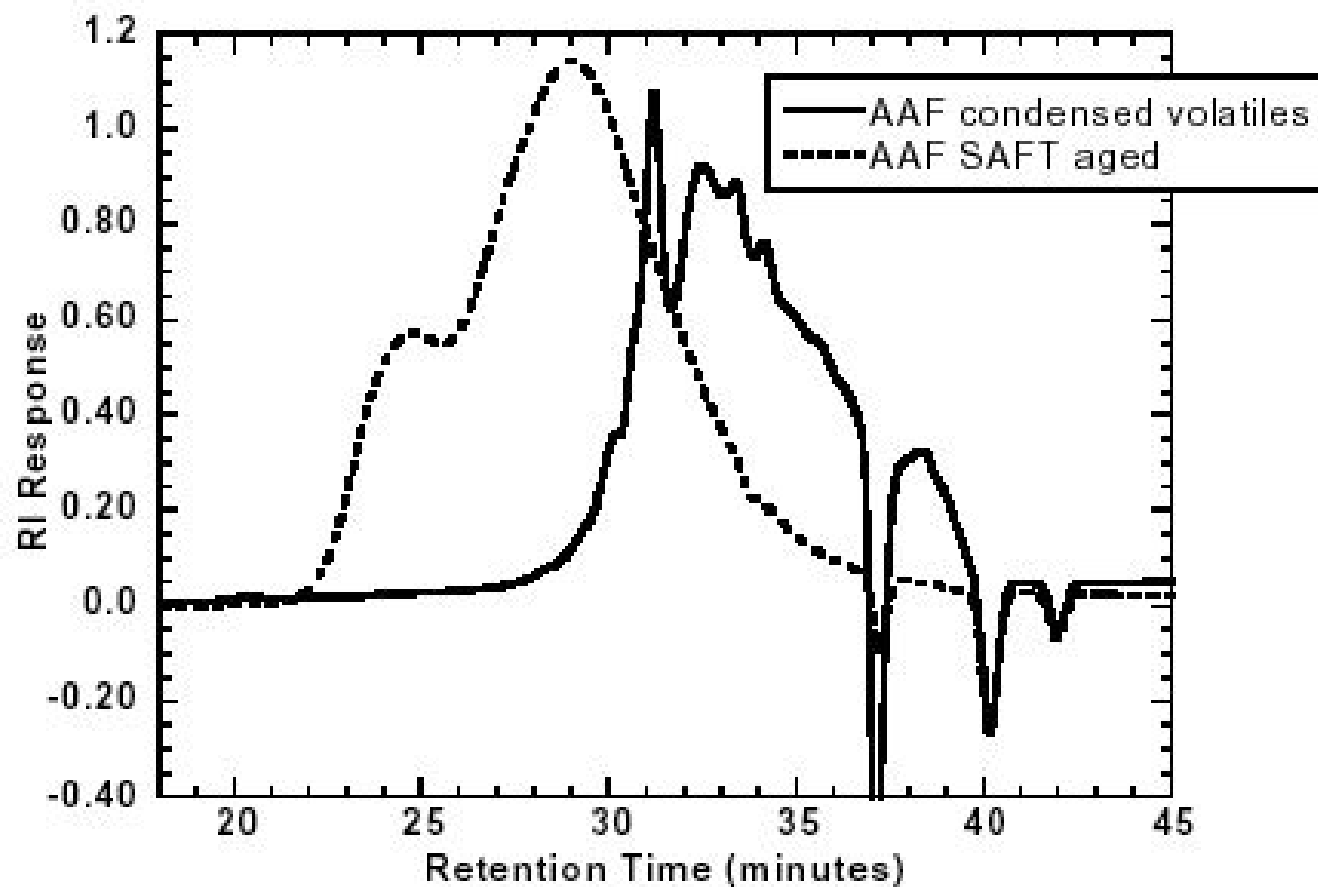
# *Volatiles Loss*



- A condenser was added
- Could be rinsed with solvent to recover and weigh volatiles
- Produced encouraging results

**Table 3-2. Condensed Volatiles and RTFOT Mass Change, Prototype Apparatus.**

Asphalt	Condensed volatiles, wt.%	RTFO/Reference Library, wt.%
A AC-10	0.013	+0.057
A AC-20	0.043	N/A
SHRP AAA-1	0.027	-0.312
SHRP AAF-1	0.045	-0.092
SHRP AAM-1	0.014	+0.052
SHRP AAS-1	0.031	-0.039
SHRP AAD-1	0.051	-0.810
SHRP ABM-1	0.035	-0.248
SHRP AAG-1	0.051	-0.180
C AC-20	0.032	-0.400
B AC-20	0.018	+0.057



**Figure 3-12. GPC Spectra of Aged SHRP AAF-1 and Condensed Volatiles, Prototype Apparatus.**







# *Round-Robin Study*

- Researchers provided 5 instruments
- Participants
  - TxDOT M&P (us)
  - Fort Worth District Lab
  - Odessa District Lab
  - Gulf States Asphalt
  - Asphalt Institute
  - TTI

# *Round-Robin Study*

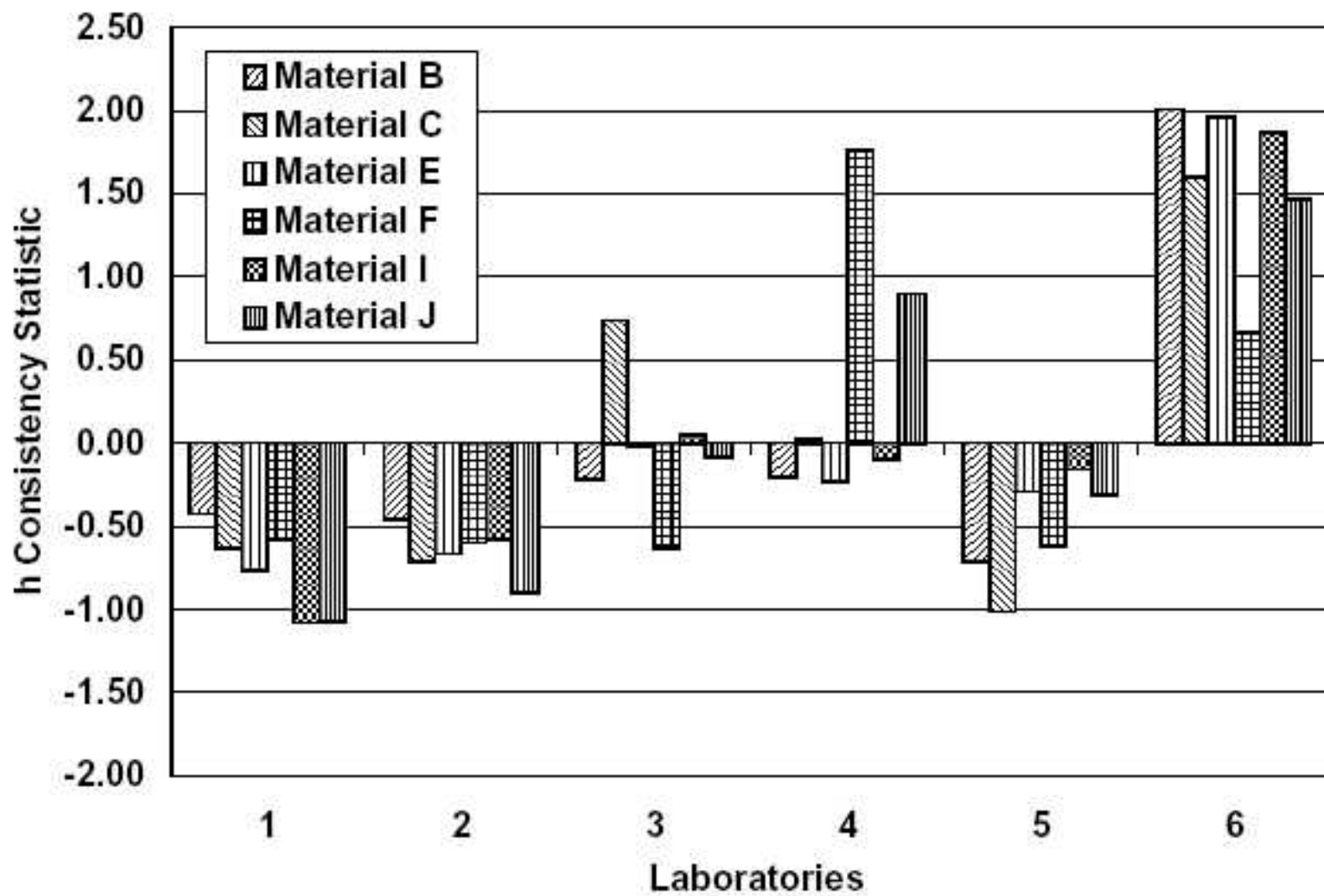


- Designed in accordance with ASTM E-691
- 6 labs and 6 materials
- RTFO and SAFT tests were run
- Results analyzed for consistency, repeatability, and reproducibility

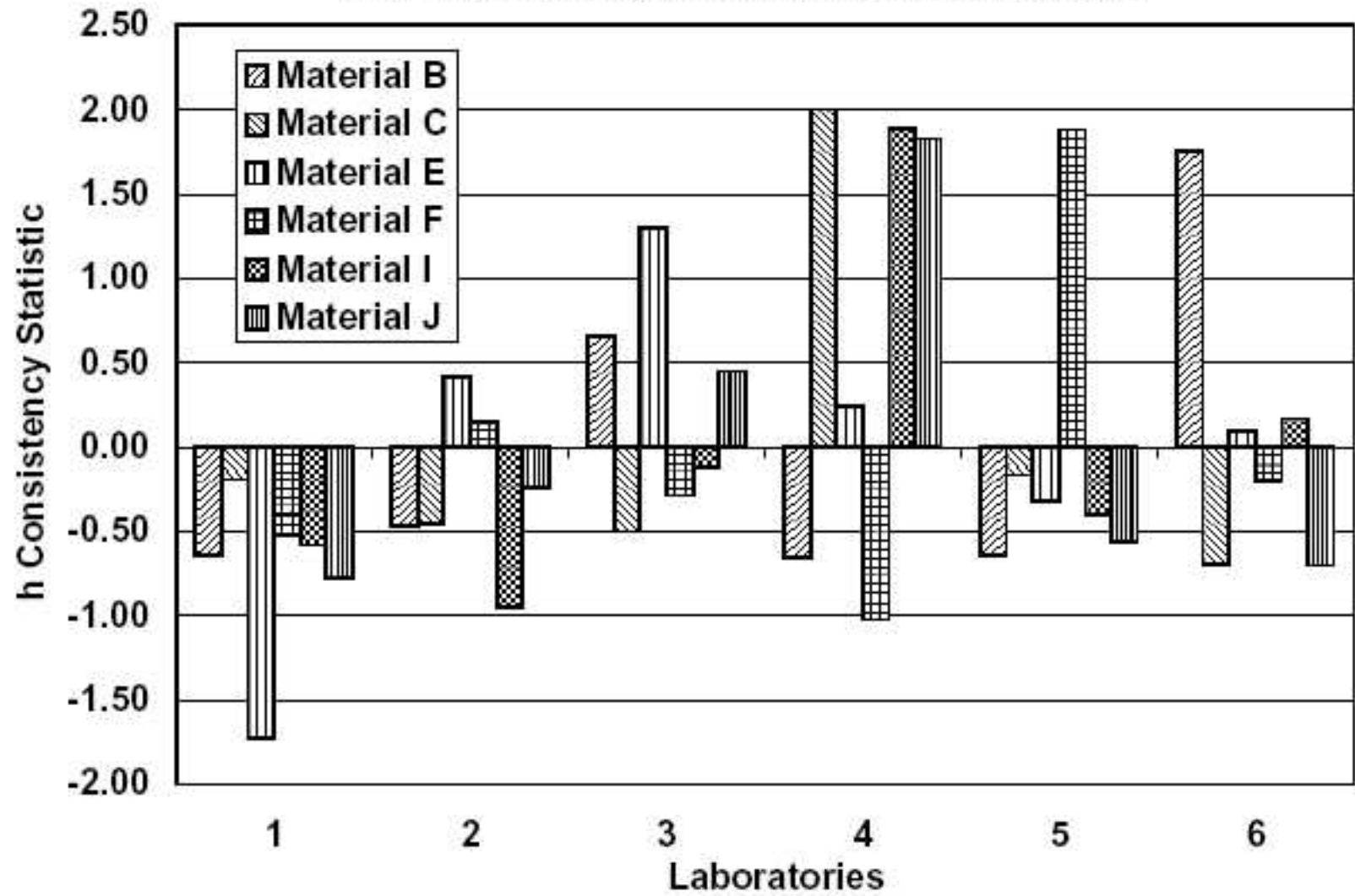
**Table 3. Precision Statistics for the Round-Robin Test.**

Precision Statistic		Material						Mean
		B	C	E	F	I	J	
$s_r$	Unaged	96	40	32	29	54	66	58
	RTFOT	48	129	92	80	86	57	86
	SAFT	290	61	191	114	59	64	155
$s_R$	Unaged	330	162	195	533	194	97	290
	RTFOT	201	253	167	183	182	198	199
	SAFT	335	456	262	254	179	125	289

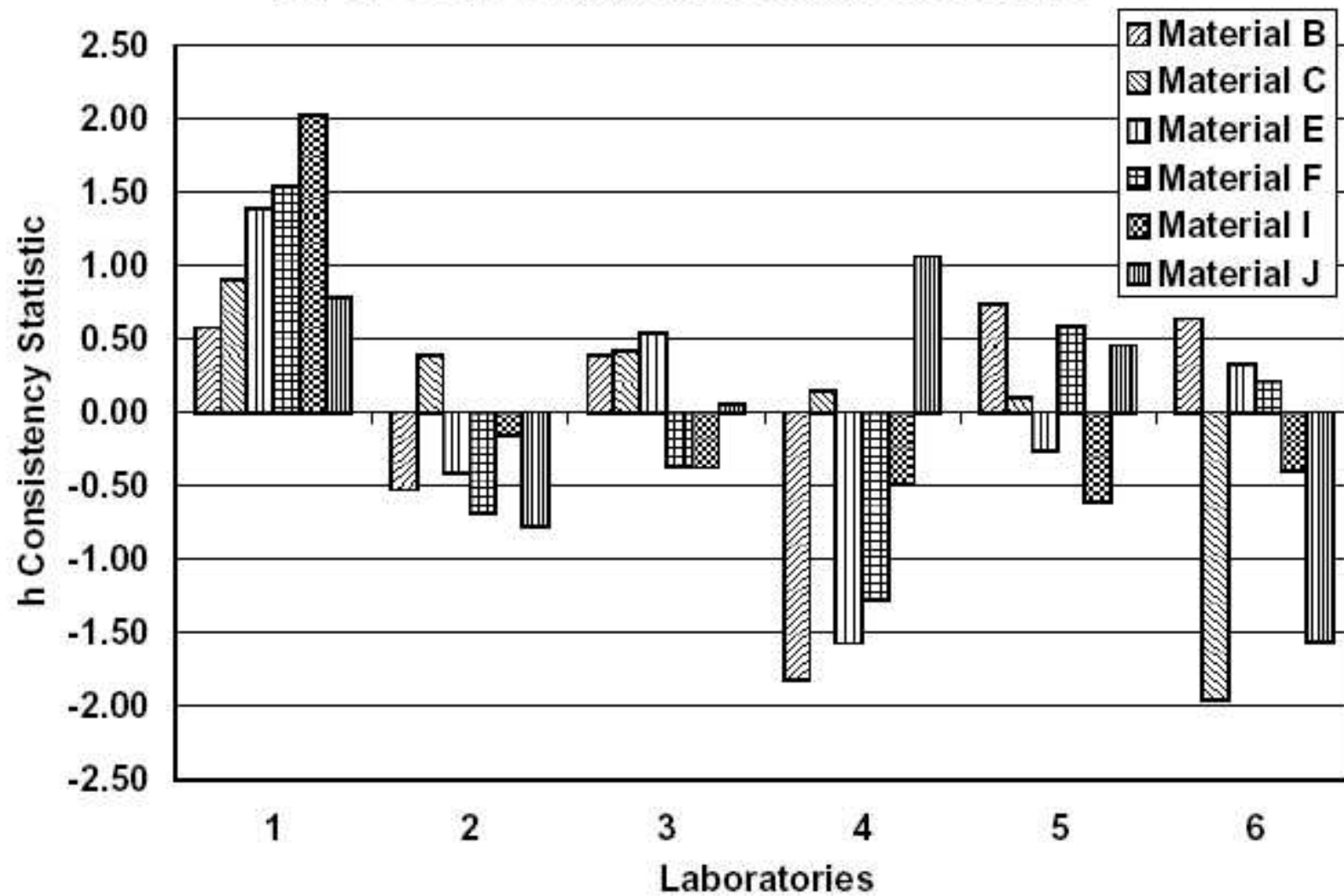
Unaged  $G^*/\sin \delta$ : h, Materials within Laboratories



SAFT  $G^*/\sin \delta$ : h, Materials within Laboratories



RTFOT  $G^*/\text{Sin } \delta$ : h, Materials within Laboratories



# *Round-Robin Findings*

- Reproducibility and repeatability
  - RTFO was slightly better than SAFT
  - SAFT numbers were not bad
  - Expected, since all of the operators were new to the test
  - Generally in good shape

# *Round-Robin Findings*



- Precision
  - No inter-laboratory biases were detected
  - Consistency with labs was also acceptable
- Volatiles Collection
  - 2 labs did not run; one had a systematic error
  - Statistics for the remaining three labs were good



# *Round-Robin Findings*

- RTFO/SAFT comparison
  - $G^*/\sin(\delta)$  was consistently lower for SAFT
  - Suggest increasing test time to 35 minutes
- No problems with modified binders were observed

# *Round-Robin Findings*



- Problems
  - Consistent stirring rate was impeded by shaft alignment and motor power
  - Suggest a redesign of the bearing/bushing and a stronger motor with a speed controller

# *Round-Robin Findings*



- Problems
  - Some temperature control problems
  - Suggest better tuning on the controller and matching nitrogen flow to air flow

# *Round-Robin Findings*



- Other suggestions
  - Use RTD rather than thermocouple
  - Provide easier-to-handle insulation
  - Use switching valves to change gas flow
  - Panel mount controls

# *Current Status*



- About to start 2nd phase of IPR
  - Redesign the instrument
  - Approach potential manufacturers
  - Purchase the instrument for interested TxDOT districts
- Still planning to use the SAFT in place of the RTFO

# *In Closing*



- Advantages of the SAFT
  - Shorter aging time
  - Better sample size
  - Mechanical agitation less sensitive to binder stiffness
  - Less mess and easier cleanup
  - Safer - no direct handling of hot equipment

# *In Closing*



- Advantages of the SAFT
  - More representative measurement of volatility
  - Smaller
  - Cheaper
  - Most parts are off-the-shelf; the ones that are not are very durable
  - Simple, familiar methodology

## *For Detailed Reports:*

- Contact TxDOT's Research and Technology Implementation Office (RTI)
  - Projects 0-1742 and 5-1742
  - Library services phone: (512) 232-3126
  - e-mail: [ctrlib@uts.cc.utexas.edu](mailto:ctrlib@uts.cc.utexas.edu)