

NCHRP 9-36 Improved Procedure for Laboratory Aging of Asphalt Binders in Pavements

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- NCHRP Project Panel
- Dr. Claine Petersen
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 - NuStar
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 - FHWA

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Outline

- Introduction
- Candidate Methods
- Selection Study
- RTFOT Verification Study
- Where Do We Go Next

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Background

- Aging Received Limited Effort During Strategic Highway Research Program
- Adopted Existing Technology
 - RTFOT for Short-Term Aging of Binders
 - PAV for Long-Term Aging of Binders
 - Oven Aging for Short- and Long-Term Aging of Mixtures
- Concerns That RTFOT May Not Be Appropriate for Polymer Modified Binders
 - Less Aging Compared to Neat Binders
 - Binders Crawl Out of Bottles

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Project Objective

- To select, refine, and validate an improved method for the short-term laboratory aging of asphalt binders
 - Address concerns with RTFOT
- Based on the physical properties of the aged binders
- For use in a purchase specification
 - Quick
 - Relatively easy to perform

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Criteria for Improved Procedure

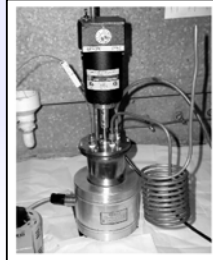
- Treat modified and neat binders equally
- Replicate RTFOT aging for neat binders
- Correlate with laboratory aging of mixtures
- Provide sufficient material for property tests
- Provide quantitative measure of volatile loss
- Timely, easy to perform
- Minimize use of organic solvents for cleaning
- Cost effective
- Extendable to long-term (in-service) aging
 - Benefit but not requirement

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Viable Methods - Literature Review

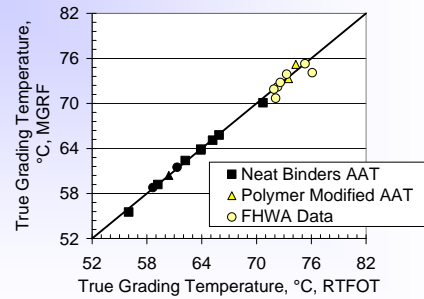
- Modified German Rotating Flask
- Stirred Air Flow Test (SAFT)



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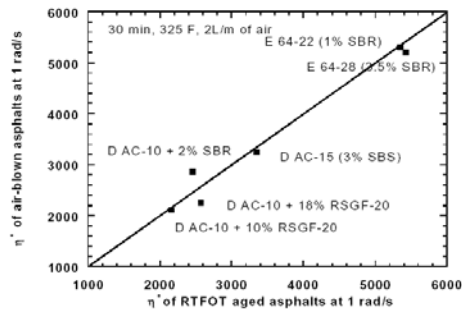
Published MGRF Results



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Published SAFT Results (Glover)



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Literature Review Findings

- Two existing procedures identified that could replace RTFOT
 - SAFT
 - MGRF
- Developing a new procedure not warranted given the two existing procedures
- Both appeared to be extendable to long-term aging
- Recommended a Selection Study
 - Evaluate the SAFT and MGRF for use in long-term aging
 - Choice between the two to be based on potential use for long-term

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Selection Study

Long-Term Aging Conditions

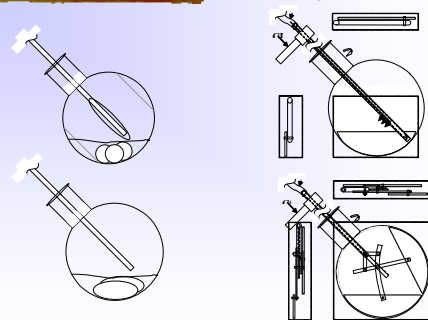
Condition	Value
Temperature	100 °C max
Atmosphere	Air at atmospheric pressure
Duration	< 48 hours
Quantity	Per current short-term testing protocol

Can We Improve Mixing at Low Temperatures?

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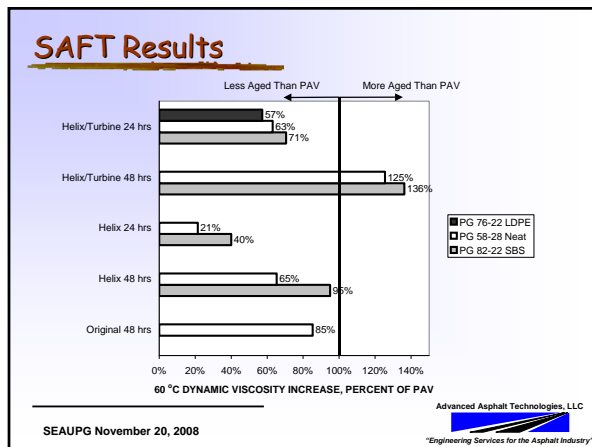
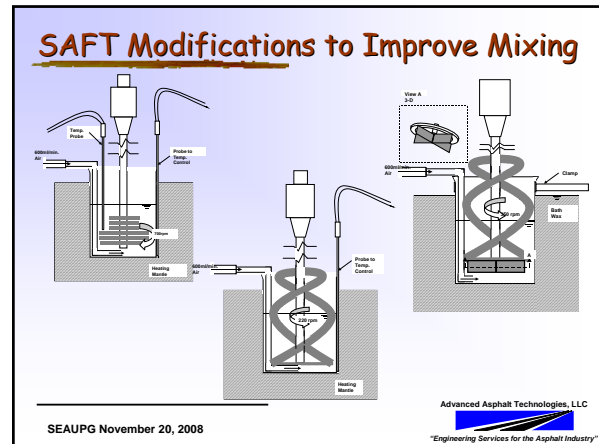
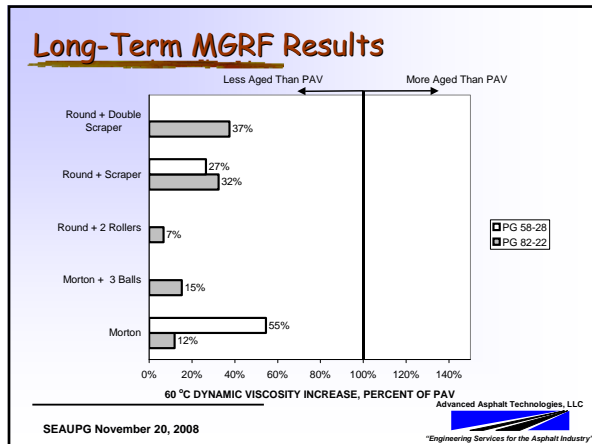
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MGRF Modifications to Improve Mixing



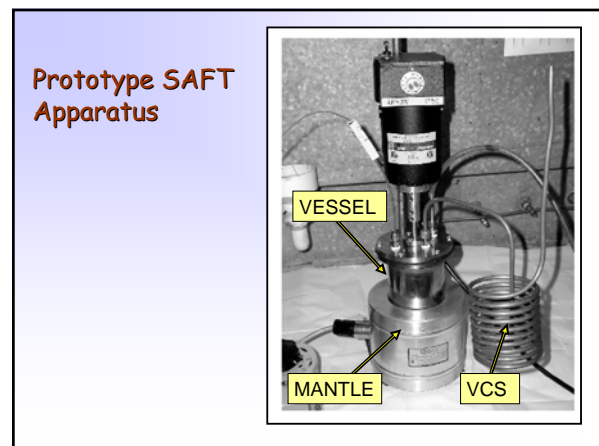
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- ### Conclusions - Selection Study
- MGRF Method as long-term procedure
 - ❑ Degree of aging is controlled by viscosity
 - ❑ Gravity not sufficient to produce required mixing
 - ❑ Mechanical aids to enhance mixing are not practical
 - SAFT Method as long-term procedure
 - ❑ Modifications to mixing system needed for long term simulation - remainder of apparatus unchanged
 - ❑ Approximately 40 hours to replicate PAV aging
 - Conclusion: SAFT more promising for long-term aging
 - ❑ Not suitable in current form - viscosity effect
 - ❑ Additional development work is needed
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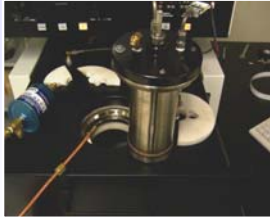
- ### Prototype SAFT vs. Commercial SAFT
- Commercial version designed and fabricated by James COX and Sons, Inc.
 - ❑ Response to TXDOT RFP
 - ❑ No published data on commercial version
 - Published data based on prototype version of SAFT
 - ❑ Developed at TTI by Dr. Glover
 - Significant difference in temperature control system between the two devices
 - ❑ Affected the rate of aging
 - ❑ Required changes to the SAFT operating parameters
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SAFT by COX



Sits on bench at convenient height



Vessel in an oven

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Changes to SAFT Operating Parameters

Parameter	Prototype SAFT	NCHRP 9-36
Sample Size	250 g	250 g
Temperature	163 C	163 C
Air Flow	2,000 ml/min	2,000 ml/min
Impeller Speed	700 RPM	1,000 RPM
Heat-up Time	15 min under Nitrogen	As required under Nitrogen
Aging Time	30 min under air	50 min under air
Degassing	None	Vacuum degassing per AASHTO R28

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Verification Study

- Twelve binders - 6 neat and 6 modified
- Binders aged with SAFT and RTFOT
 - Continuous Grading
 - Mastercurves
 - Aging Indices
- Mixtures aged per AASHTO R30 (4 hours at 135 °C)
 - Ranking of aging
 - SAFT Relative to AASHTO R30
 - RTFOT Relative to AASHTO R30
- Criterion - replacement test must mimic RTFOT for neat binders

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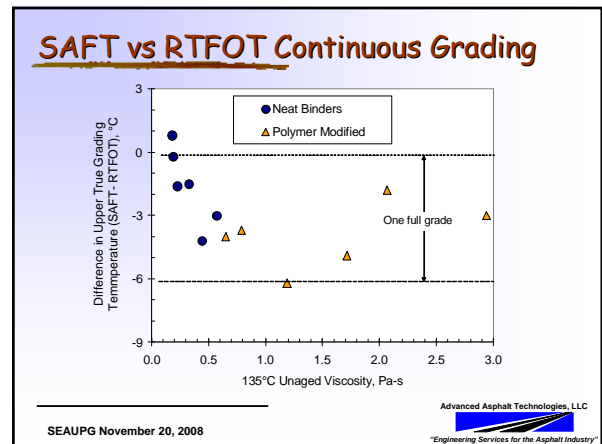
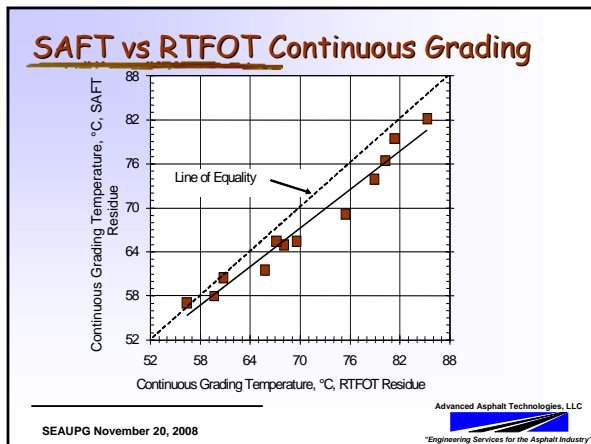
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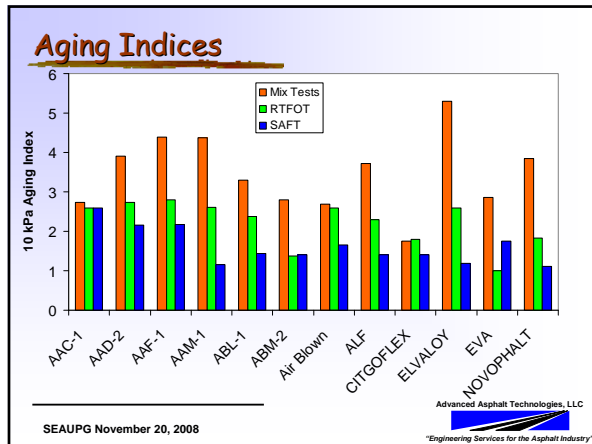
Binders for Verification Study

Binder	Type
AAC-1	Neat
AAD-2	Neat
AAF-1	Neat
ABM-2	Neat
ABL-1	Neat
AAM-1	Neat
Citgoflex	PG 82-22 SBS Modified
ALF 64-40	PG 70-34 SBS Modified
Air Blown	PG 76-16
Evaloy	PG 76-22 RET Modified
EVA	PG 76-22 EVA Modified
Novophalt	PG 76-22 LDPE Modified

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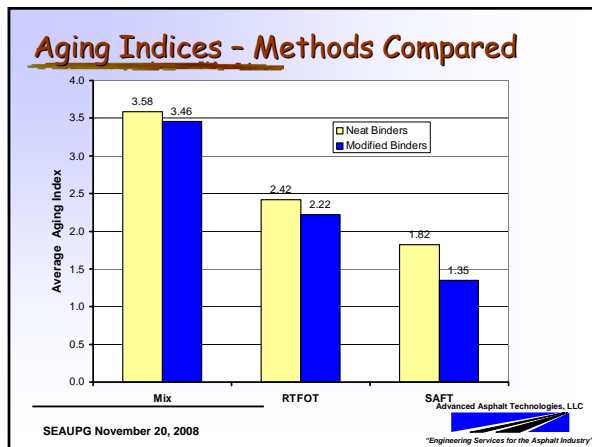


AI Rankings Compared

Binder	Ranking by Aging Index		
	R30	RTFOT	SAFT
AAC-1	9	5	1
AAD-2	4	2	2
AAF-1	2	1	3
AAM-1	3	3	10
ABL-1	7	7	5
ABM-2	8	11	7
Air Blown	10	6	4
ALF	6	8	6
CITGOFLEX	11	10	8
ELVALOY	1	4	9
NOVOPHALT	5	9	11
SPEARMAN RANK CORRELATION COEFFICIENT		0.66	-0.22

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- ### Conclusions
- Aging in SAFT Relative to RTFOT is Viscosity Dependent
 - SAFT ages stiffer binders less
 - AASHTO R30 Ages Binders More Than RTFOT, but...
 - AASHTO R30 and the RTFOT Rank Binder Aging Similarly
 - AASHTO R30, RTFOT, and SAFT Treat Neat and Modified Binders Equally
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- ### What is Next?
- Repeat Verification Experiment Using MGRF
 - Possible Outcomes
 - Recommend Using MGRF
 - Recommend RTFOT
 - Improvements
 - Additional Work to Be Completed in Next 6 Months
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- ### Final Thought
- Comprehensive evaluation of aging of binders and mixtures is needed
 - RTFOT based on data from 1970's
 - Current plants
 - Warm Mix
 - Limited verification of PAV during SHRP
 - Service time simulated by PAV is binder dependent
 - Supporting data for AASHTO R-30 very limited
 - Short-term
 - Long-term
 - Warm Mix
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Thanks for your attention

Questions?
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Answers?
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