

# Vacuum Degassing of PAV Residue Always – Never - Optional?

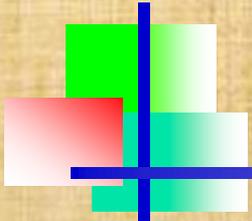
## Task Force on Vacuum Degassing

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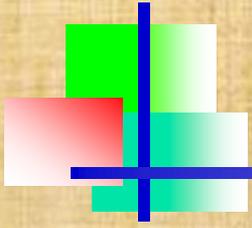
September 16-17, 2014



## Problem Statement – Current Status

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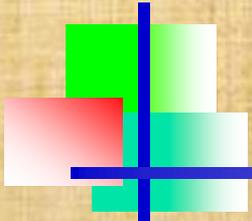
- ❑ The effect of vacuum degassing PAV residue before conducting BBR or DSR testing has once again been raised
- ❑ Initiated by comments at RMUPG Binder technician Workshop that w/o degassing bubbles are hard to remove and residual bubbles affect test results
  - ✓ Contradicts previous results presented at ETG
- ❑ Task force was established at last ETG meeting to re-evaluate vacuum degassing
- ❑ Report on current status of task force work



# First Efforts of Task Force

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- ❑ Initially envisioned as simple study to validate previous decision that degassing should be optional
- ❑ Envisioned experiment with following variables
  - ✓ Rate of pressure release
  - ✓ Laboratory elevation
  - ✓ Binder source to include PMB's
  - ✓ Manufacturer of PAV – degassing rate
- ❑ After some reflection decided to do some background work
  - ✓ Initial experiment put on hold



# Work to Date and Future Direction

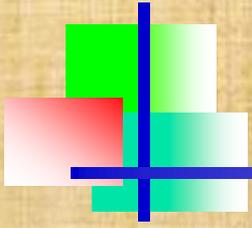
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## □ Work to date

- ✓ Investigated linearity of pressure release rate
- ✓ Reviewed previous degassing experiments
- ✓ Informal survey of RMAUPG workshop attendees

## □ Future Direction

- ✓ Re-evaluate direction based on input at ETG meeting
- ✓ Develop and conduct experimentation as appropriate
- ✓ Develop recommendations for test procedure updates

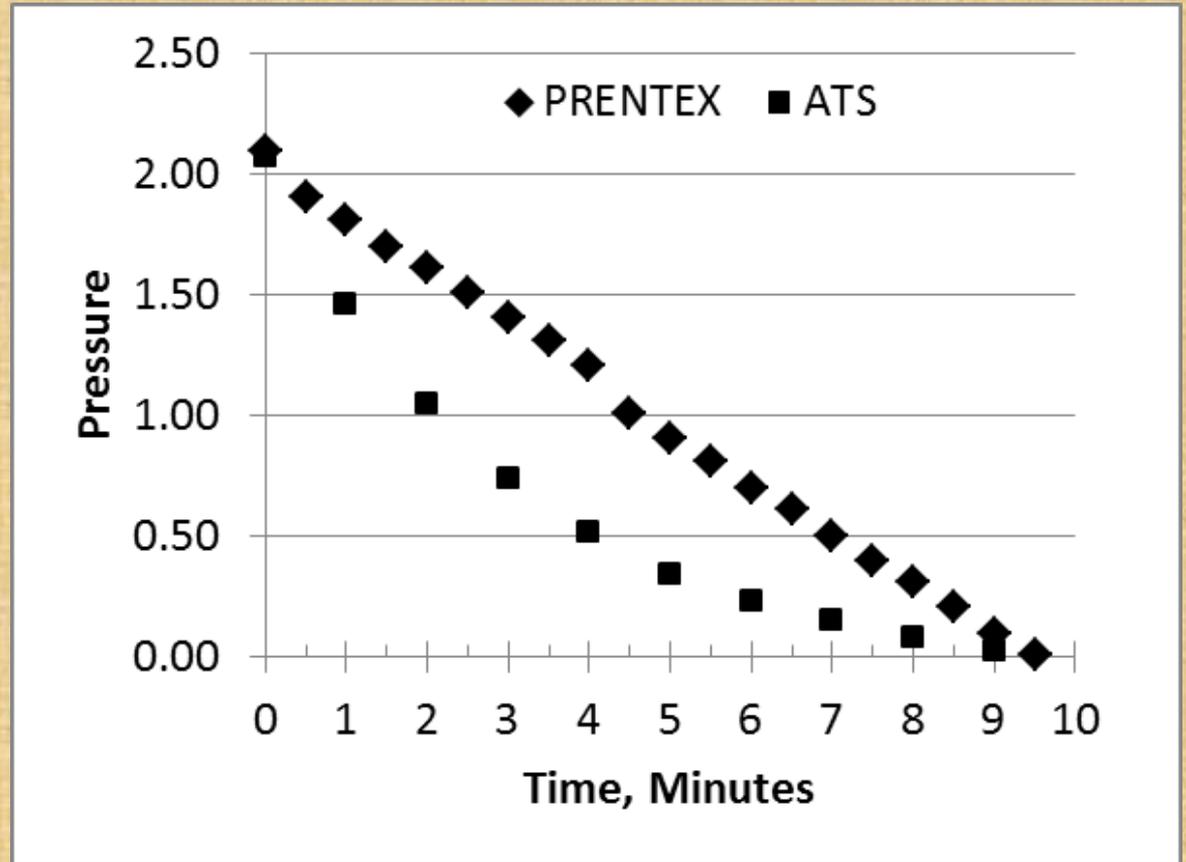


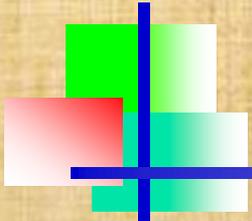
# Linearity of Pressure Release Rate

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- ❑ Reviewed as possible cause of excessive bubbles
- ❑ Pressure vs. release rate obtained from several labs
  - ✓ Prentex releases linearly in series of small bursts
    - Meets requirements of test method
  - ✓ ATS releases 50% in first 90 seconds
    - Does not meet requirements of test method
- ❑ Above verified by data from several laboratories
- ❑ Release rate from lab most vocal about degassing uses Prentex
  - ✓ Cannot attribute labs concern to pressure release rate

# Pressure Release Rate – Typical Results

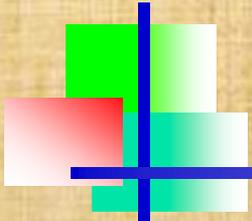




# Pressure Release Rate - Summary

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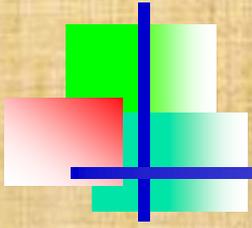
- ❑ Release rate not linear for one PAV manufacturer
  - ✓ 50% Pressure released in 1<sup>st</sup> 2 minutes
  - ✓ Effect on bubble formation is unknown
- ❑ Test method requirements are ambiguous
  - ✓ AASHTO specifies “approximately linear” rate
  - ✓ ASTM silent on linearity
  - ✓ Linear rate specified during original PAV development in recognition of effect on bubble formation
- ❑ Effect of release rate on bubble formation and measured properties unknown
  - ✓ Where do we go from here?



# Vacuum Degassing - Historical

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- ❑ Vacuum degassing was adopted to enhance repeatability of direct tension test data (19xx)
  - ✓ Not part of original DSR and BBR test protocols
  - ✓ Adopted after bubbles were shown to affect DTT results
  - ✓ Subsequently dropped when DTT was discontinued
- ❑ Vacuum degassing protocol was developed based on results of limited laboratory testing program
  - ✓ Preheating combined sample at  $175^{\circ}\text{C}$  for  $10 \pm 1$  min
  - ✓ Vacuum at  $15 \pm 2.5$  kPa (Absolute) for  $30 \pm 1$  min
  - ✓ Included stirring and flashing steps



# Previous Studies on Degassing Summarized by G. Reinke, ETG 7/07

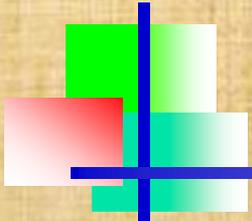
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- ❑ Study 1

- ✓ PG 64-22, 58-28, PG 64-28P, PG 70-28P
- ✓ Concluded no difference in BBR/DSR results

- ❑ Conclusion: Based on the results of this investigation there appears to be no need to continue performing vacuum de-gassing if the Direct Tension Test is not going to be performed

- ❑ Recommended follow-on study



# Previous Studies on Degassing (Cont'd)

Summarized by G. Reinke, ETG 7/07

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## ❑ Study 2 – Asphalt Institute

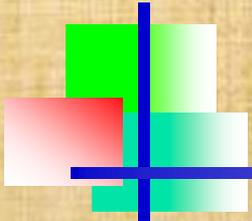
- ✓ MSCR binders, PG 64-22, 76-22, 64-34, 70-28, 70-34
- ✓ One operator, TAI Laboratory
- ✓ Concluded no difference

## ❑ Study 3 - WCTG Study

- ✓ Multiple laboratories ( $\approx 38$ )
- ✓ PG 62-22, 76-22, 70-28
- ✓ No differences except for BBR for 76-22

❑ All of above studies show some outliers

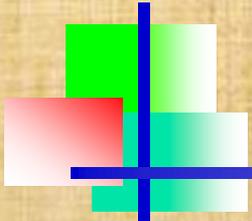
❑ Conclusion: Degassing not required



# Survey of RMAUPG Workshop Attendees

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1. Do you routinely degas PAV residue? Y 5/6
2. Do you feel that PAV spec should give the option to degas? Y 3/6
3. Do you feel that PAV spec should require degassing? Y 4/6
4. Do you stir the residue or flash with a heat gun or torch to remove bubbles? Y 6/6



# Survey of RMAUPG Workshop Attendees

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5. Do you have any data that show differences in the BBR properties of degassed versus non-degassed residue?

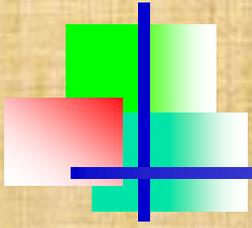
- ✓ Two labs gave limited information supporting differences
- ✓ Limited data suggesting difference

Without degassing:  $S = 126$ ,  $m = 0.371$

With degassing:  $S = 166$ ,  $m = 0.316$

6. Please include any comments you consider relevant.

- ✓ Option should be avoided for sake of consistency (2)
- ✓ Some binders impossible to pour e.g. emulsion residue
- ✓ Heavily modified residues are problematic



# No Degassing vs. Degassing - Possible Effects

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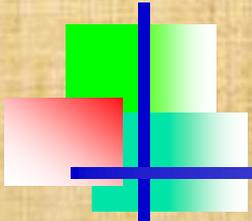
## No degassing

- ✓ Is pressure release rate a factor?
- ✓ Bubbles flashed from pan upon removal?
- ✓ Residue properly stirred?
- ✓ Effect of residual bubbles:  $G^* \downarrow$ ,  $\delta ?$ ,  $S \downarrow$ ,  $m?$

## Degassing

- ✓ Used in lieu of steps above?
- ✓ Extra heating:  $G^* \uparrow$ ,  $\delta \downarrow$ ,  $S \uparrow$ ,  $m \downarrow$
- ✓ Improper heating before degassing?  $G^* \downarrow$ ,  $\delta ?$ ,  $S \downarrow$ ,  $m?$
- ✓ Can degassing increase variability?

## Is option a good idea?



# Degassing in Current Test Methods

## Yes? – No? – Optional?

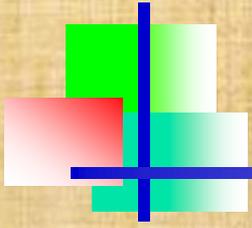
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### ☐ Degassing BBR Test Method

- ✓ AASHTO – 11.3. If also being tested according to T 314 (DT) and has been conditioned according to T 240 (RTFO) and R 28 (PAV), degas... Otherwise, degassing of the asphalt binder sample is not required.
- ✓ ASTM - Silent but PAV procedure includes degassing

### ☐ Degassing DSR Test Method

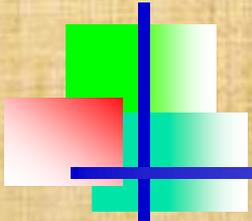
- ✓ AASHTO T 313 If .... tested according to T 314 (DT) and .... conditioned according to T 240 (RTFO) and R 28 (PAV), degas .... prior to testing. Otherwise, degassing of the sample is not required.
- ✓ ASTM - Silent but PAV procedure includes degassing



# Some Unanswered Questions

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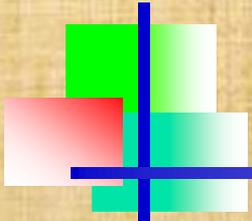
- Does degassing significantly affect test results?
  - ✓ Significantly → Enough to effect acceptance-rejection?
  - ✓ If so, is effect more prevalent for modified binders?
  - ✓ Some modified binders or all?
- Should PAV spec be modified to accommodate non-conforming equipment manufacturer?
  - ✓ Is release rate important with or without degassing?
- Are enhancements needed for R 28?
  - ✓ Absolute pressure gage required
  - ✓ Heating time before applying vacuum
  - ✓ Time under vacuum



# Some Task Force Findings to Date

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- ❑ Pressure release rate non-linear for one device
  - ✓ No data to show contribution to “problem”
- ❑ Some labs use vacuum degassing as fall-back for bubble removal whether needed or not
  - ✓ Is this good practice?
- ❑ Test methods are inconsistent
  - ✓ Requirement for degassing and linearity issue need to be clarified
- ❑ Anecdotal information contradicts previous findings
  - ✓ Practitioners question “no effect” conclusion



# What is Needed?

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- ❑ Study to quantify effect of selected variables
  - ✓ Elevation of laboratory – high or low
  - ✓ Binder type – plain, modified, heavily modified
  - ✓ Procedural details – release rate, degassing
- ❑ Recommended updates to test methods
  - ✓ PAV: Linearity issue, procedural issues
  - ✓ BBR and DSR: Consistent wording relative to yes, no, optional
- ❑ Round robin
  - ✓ Properly identified variables and associated analysis