Problem Statement – Current Status

- 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

- 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

- **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

- 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

![Graph showing pressure release rate over time for PRENTEX and ATS.]
Pressure Release Rate - Summary

- Release rate not linear for one PAV manufacturer
  - 50% Pressure released in 1st 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 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°C for 10 ± 1 min
- Vacuum at 15 ± 2.5 kPa (Absolute) for 30 ± 1 min
- Included stirring and flashing steps
Previous Studies on Degassing
Summarized by G. Reinke, ETG 7/07

- **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**
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 (≈ 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

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
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

- 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?

- **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

- 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

- 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
  - Practicioners question “no effect” conclusion
What is Needed?

- 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