

ENGINEERING ENVIRONMENTAL CONSULTING SERVICES

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Mr. Mike Zais
Chairman, UEF Subcommittee
American Composites Manufacturing Association

Mike:

Attached is a draft Petition to incorporate a new styrene emission factor for the compression molding of Bulk Molding Compound (BMC) and Liquid Compression Molding (LCM) parts into the Unified Emission Factors (UEF).

Please ask the participating Relevant Committee members to review, approve, and submit this petition to the ANSI process for adoption as part of the UEF factors.

Please consider including Perry Bennett of MFG, Walt McSherry of Premix, Bob Lacovara of Convergent Composites, and Tony Becker of the Ohio EPA in the voting Canvas Panel. These persons were directly involved with the testing and have important first-hand knowledge of the test circumstances.

Best regards



Robert A. Haberlein, Ph.D., QEP

cc:

Larry Cox, UEF/ANSI Secretariat at ACMA
Jay Merrill, Chairman of the GAC Committee
David Hertzog, Chairman of the Technical Committee
Pete Emrich, Chairman of the CMRC Committee

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1. Introduction

Attachments

The following attachments and appendices contain the bulk of the test information, data, and calculations:

- Feasibility Report – *Feasibility of a Temporary Total Enclosure for Measuring the Process Emissions from Compression Molding Manufacturing*; EECS; July 30, 2008
- Test Protocol – *Test Protocol to determine the Process Emissions from Compression Molding using a TTE Enclosure to measure the VOC Emissions from Charge Preparation and Material Handling*; EECS; July 21, 2008
- Test Report – *Test Results: Styrene Emissions from BMC and LCM Compression Molding during Charge Preparation and Material Handling*; EECS; October 12, 2009

Appendices to the Test Report:

- Appendix A – BMC/LCM test charge photographs
- Appendix B – TTE enclosure, test equipment and test setup photographs
- Appendix C – BMC field notes and data sheets
- Appendix D – LCM field notes and data sheets
- Appendix E – FID concentration plots

2. Test Methods and Test Procedures

The testing incorporated the following EPA reference test methods:

- Method 1
- Method 2
- ASHRAE psychrometric equations (approved alternative to Methods 3 & 4 for moist air)
- Method 25A
- Method 204

This protocol was reviewed prior to testing and approved by the Ohio EPA. A group of field inspectors from the Ohio EPA visited the test site and observed the actual testing.

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3. BMC and LCM Test Charges

The BMC and LCM test charge dimensions and other pertinent charge parameters are listed in Section II of the Test Report. Photographs of each BMC and LCM test charge are provided in Appendix A to the Test Report.

4. Test Data and Data Quality Control

The test data is listed in Section III of the Test Report and summarized in Table 1 on the next page of this petition. The data quality control is described in Section IV of the Test Report.

5. BMC and LCM Compression Molding Factor Derivation

The proposed BMC part emission factor is the arithmetic average of test results for the six individual test runs. The emission factor is expressed as a percentage of the available styrene monomer contained in the uncured BMC material that is processed in the compression mold. The calculation of this average is shown in Table 1 and is discussed in Section V of the Test Report.

The proposed LCM part emission factors are the linear equation regressed from the spread paste and poured paste data sets (twelve runs each). These emission factor equations are expressed as a percentage of the processed paste weight, which is consistent with the format used for the other UEF emission factors. The linear regressions are detailed in Section V of the Test Report. The LCM data and liner regression statistics are plotted in Figure 1 on the last page of this petition.

6. Proposed UEF Table Entries for BMC and LCM Compression Molding

The proposed entry for the BMC Part Compression Molding factor will be:

1.15% of the styrene monomer content in the processed BMC material

The proposed entry for the LCM Part Compression Molding factor will consist of two separate equations, one equation for spread LCM paste and one for poured LCM paste:

- LCM spread paste factor (% of paste wt) = $0.0072 \times \%styrene + 0.0008$
- LCM poured paste factor (% of paste wt) = $0.0022 \times \%styrene + 0.0008$

The “%styrene” input value in these equations must be in decimal form instead of percentage (0.20 instead of 20%). These equations generate the factor as a percent of the processed paste weight.

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Table 1 – Summary of the Detailed Test Results

| BMC Charge | BMC Run | Styrene Content (% wt) | BMC Material Factor (% wt) | | Styrene Monomer Factor (% wt) | |
|------------|---------|------------------------|----------------------------|---------|-------------------------------|---------|
| | | | Run | Average | Run | Average |
| 1 | Run 1-1 | 11.84% | 0.085% | 0.085% | 0.72% | 0.72% |
| | Run 1-2 | | 0.081% | | 0.68% | |
| | Run 1-3 | | 0.089% | | 0.75% | |
| 2 | Run 2-1 | | 0.190% | 0.187% | 1.61% | 1.58% |
| | Run 2-2 | | 0.158% | | 1.33% | |
| | Run 2-3 | | 0.213% | | 1.80% | |
| | | | Overall Average | | Overall Average | |
| | | | 0.14% | | 1.15% | |

| LCM Charge | LCM Run | Styrene Content (paste) (% wt) | LCM Paste Factor (% wt) | | Styrene Monomer Factor (% wt) | |
|------------|---------|--------------------------------|-------------------------|---------|-------------------------------|---------|
| | | | Run | Average | Run | Average |
| 1 | Run 1-1 | 24.45% | 0.124% | 0.131% | 0.51% | 0.54% |
| | Run 1-2 | | 0.126% | | 0.52% | |
| | Run 1-3 | | 0.143% | | 0.58% | |
| 2 | Run 2-1 | | 0.126% | 0.136% | 0.52% | 0.55% |
| | Run 2-2 | | 0.130% | | 0.53% | |
| | Run 2-3 | | 0.150% | | 0.61% | |
| 3 | Run 3-1 | 15.18% | 0.270% | 0.250% | 1.11% | 1.02% |
| | Run 3-2 | | 0.243% | | 0.99% | |
| | Run 3-3 | | 0.236% | | 0.97% | |
| 4 | Run 4-1 | | 0.258% | 0.267% | 1.06% | 1.09% |
| | Run 4-2 | | 0.271% | | 1.11% | |
| | Run 4-3 | | 0.271% | | 1.11% | |
| 5 | Run 5-1 | 15.18% | 0.077% | 0.078% | 0.51% | 0.51% |
| | Run 5-2 | | 0.076% | | 0.50% | |
| | Run 5-3 | | 0.080% | | 0.53% | |
| 6 | Run 6-1 | | 0.167% | 0.176% | 1.10% | 1.16% |
| | Run 6-2 | | 0.186% | | 1.23% | |
| | Run 6-3 | | 0.175% | | 1.15% | |
| 7 | Run 7-1 | 15.18% | 0.156% | 0.149% | 1.02% | 0.98% |
| | Run 7-2 | | 0.149% | | 0.98% | |
| | Run 7-3 | | 0.141% | | 0.93% | |
| 8 | Run 8-1 | | 0.205% | 0.206% | 1.35% | 1.36% |
| | Run 8-2 | | 0.210% | | 1.39% | |
| | Run 8-3 | | 0.204% | | 1.35% | |
| | | | Overall Average | | Overall Average | |
| | | | 0.17% | | 0.90% | |

Figure 1 – Plot of LCM Paste Factor versus Styrene Content

