



Emissions Inventory Help Sheet for Polyester Resin Application

What do I need to report?

Manufacturing products from polyester resins causes monomers in the resins to be emitted. Styrene, the most common monomer, is a volatile organic compound (VOC). Methyl methacrylate (MMA), another less common monomer, is also a VOC. Emissions (including DMP, MEKP and MEK) from the catalyst are normally very small and may be disregarded for this report. These materials and processes should be reported:

- Usage of resins and gelcoats used for fiberglass and cast polymer products such as cultured marble, statuary, and countertops.
- Cleaning materials used other than acetone. (Do not report acetone.)
- Dust generated by cutting or sanding wood, fiberglass, and cast polymer products.

What emission units do I use?

Use the Emission Unit type 'Polyester Resin' for resins and gelcoats discussed on this help sheet. Use the Emission Unit type of 'Solvent Use' for cleaning materials and use the Emission Unit type 'Woodworking Equipment' for reporting dust emissions (see the help sheet for Woodworking). The AQD Online Portal Emissions Inventory Instructions has more detailed information for creating Emission Units and submitting an emission inventory.

What are my resin and gelcoat emission factors (EFs)?

Emission factors for resins and gelcoats are determined based on the application method and the percent content of styrene and MMA in each material. Refer to the safety data sheet (SDS) for each resin and gelcoat to determine the percent content of styrene and MMA in each material. Use the table on the next page to determine the EF for each resin and gelcoat application process. Most manufacturers' test data which claim emission factors different from those included in this help sheet do not meet EPA specifications and cannot be accepted.

Examples:

1. A resin containing 45% styrene is applied using a spray layup method (without vapor suppression or controlled atomization). $EF = 0.141 \text{ lb/lb}$.
2. A resin containing 45% styrene is applied using a hand-layup method (without vapor suppression). $EF = 0.076 \text{ lb/lb}$.
3. An open polymer casting process uses a resin containing 35% styrene. $EF = 0.02 \times 0.35 = 0.007 \text{ lb/lb}$.
4. A gelcoat containing 35% styrene and 10% MMA is spray applied. $EF = 0.168 + 0.075 = 0.243 \text{ lb/lb}$ (EF is calculated by adding emission factors for the styrene and MMA).

How do I calculate my emissions?

Download the Material Usage Calculation Tool excel file and instructions (<https://www.maricopa.gov/1820>). This tool can be used to enter the amount used and emission factors for all of your VOC or ammonia gas (NH_x) emitting compounds and will calculate your emissions. The results can be entered directly into the AQD Online Portal. The excel file will need to be uploaded into the AQD Online Portal to show your calculations.

Styrene Emission Factors*

Emission Rate in Pounds of Styrene (VOC) Emitted per Pound of Resin or Gelcoat Processed [resin weight is “neat” (without filler), as applied]

| Styrene content in resin/gelcoat, % ⁽¹⁾ | <33 ⁽²⁾ | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | >50 ⁽²⁾ |
|--|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-----------------------------------|
| Manual (hand layup) | 0.126 × % styrene | 0.041 | 0.044 | 0.047 | 0.05 | 0.053 | 0.056 | 0.059 | 0.062 | 0.064 | 0.067 | 0.07 | 0.073 | 0.076 | 0.079 | 0.082 | 0.084 | 0.087 | 0.09 | (0.286 × % styrene) – 0.0529 |
| Manual w/ vapor suppressed resin (VSR) | Manual emission factor listed above × 1 – (0.50 × specific VSR reduction factor for each resin/suppressant formulation) | | | | | | | | | | | | | | | | | | | |
| Mechanical atomized (spray layup) | 0.169 × % styrene | 0.056 | 0.063 | 0.07 | 0.077 | 0.084 | 0.091 | 0.098 | 0.106 | 0.113 | 0.12 | 0.127 | 0.134 | 0.141 | 0.148 | 0.156 | 0.163 | 0.17 | 0.177 | (0.714 × % styrene) – 0.18 |
| Mechanical atomized with VSR | Mechanical atomized emission factor listed above × 1 – (0.45 × specific VSR reduction factor for each resin/suppressant formulation) | | | | | | | | | | | | | | | | | | | |
| Mechanical atomized controlled spray | 0.130 × % styrene | 0.043 | 0.049 | 0.054 | 0.060 | 0.065 | 0.071 | 0.076 | 0.082 | 0.087 | 0.093 | 0.098 | 0.104 | 0.109 | 0.115 | 0.120 | 0.126 | 0.131 | 0.137 | 0.77 × (0.714 × % styrene) – 0.18 |
| Mech. atomized controlled spray with VSR | Mechanical atomized controlled spray emission factor listed above × 1 – (0.45 × specific VSR reduction factor for each resin/suppressant formulation) | | | | | | | | | | | | | | | | | | | |
| Mechanical non-atomized | 0.107 × % styrene | 0.036 | 0.037 | 0.039 | 0.04 | 0.042 | 0.043 | 0.045 | 0.047 | 0.048 | 0.05 | 0.051 | 0.053 | 0.054 | 0.056 | 0.058 | 0.059 | 0.061 | 0.062 | (0.157 × % styrene) – 0.0165 |
| Mechanical non-atomized with VSR | Mechanical non-atomized emission factor listed above × 1 – (0.45 × specific VSR reduction factor for each resin/suppressant formulation) | | | | | | | | | | | | | | | | | | | |
| Filament application | 0.184 × % styrene | 0.061 | 0.064 | 0.066 | 0.069 | 0.072 | 0.075 | 0.077 | 0.08 | 0.083 | 0.086 | 0.088 | 0.091 | 0.094 | 0.097 | 0.099 | 0.102 | 0.105 | 0.108 | (0.2746 × % styrene) – 0.0298 |
| Gelcoat application | 0.445 × % styrene | 0.147 | 0.157 | 0.168 | 0.178 | 0.188 | 0.199 | 0.209 | 0.219 | 0.23 | 0.24 | 0.25 | 0.261 | 0.271 | 0.282 | 0.292 | 0.302 | 0.313 | 0.323 | (1.03646 × % styrene) – 0.195 |
| Gelcoat non-atomized application | See Note (3) below | 0.098 | 0.103 | 0.107 | 0.112 | 0.116 | 0.121 | 0.125 | 0.13 | 0.134 | 0.139 | 0.143 | 0.148 | 0.152 | 0.157 | 0.161 | 0.166 | 0.17 | 0.175 | (0.4506 × % styrene) – 0.0505 |
| Covered-cure after roll-out | Non-VSR emission factor listed above × (0.80 for manual or 0.85 for mechanical application) | | | | | | | | | | | | | | | | | | | |
| Covered-cure without roll-out | Non-VSR emission factor listed above × (0.50 for manual or 0.55 for mechanical application) | | | | | | | | | | | | | | | | | | | |
| Polymer Casting ⁽²⁾ | Open Casting | | | | | | | | | | Machine-Enclosed Casting | | | | | | | | | |
| | 0.02 x % styrene | | | | | | | | | | 0.01 x % styrene | | | | | | | | | |

Methyl Methacrylate (MMA) Emission Factors*

Emission Rate in Pounds of MMA (VOC) Emitted per Pound of Gelcoat Processed

| MMA content in gelcoat, % ⁽⁴⁾ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | ≥ 20 ⁽²⁾ |
|--|---------------------|-------|-------|------|-------|-------|-------|------|-------|-------|---------------------------------|------|-------|-------|-------|------|-------|-------|-------|---------------------|
| Spray Application | 0.0075 | 0.015 | 0.023 | 0.03 | 0.038 | 0.045 | 0.053 | 0.06 | 0.068 | 0.075 | 0.083 | 0.09 | 0.098 | 0.105 | 0.113 | 0.12 | 0.128 | 0.135 | 0.143 | 0.75 × %MMA |
| Polymer Casting ^(2, 5) | Open Casting | | | | | | | | | | Machine-Enclosed Casting | | | | | | | | | |
| | 0.16 x % MMA | | | | | | | | | | 0.08 x % MMA | | | | | | | | | |

*Except where otherwise noted, this table was adapted from the “Technical Discussion of the Unified Emission Factors for Open Molding of Composites” (Haberlein, April 1999), available at <http://infohouse.p2ric.org/ref/43/42018.pdf>. Maricopa County converted the data to pounds of VOC emitted per pound instead of per ton of resin/gelcoat.

Notes:

- (1) Including styrene monomer content as supplied, plus any extra styrene monomer added by the molder, but before addition of other additives such as powders, fillers, glass, etc.
- (2) The value for “% styrene” or “% MMA” in the formulas should be input as a fraction. For example, use the input value **0.30** for a resin with 30% styrene content by weight.
- (3) For styrene contents between 19% and 32%, use the equation: (0.4506 × % styrene) – 0.0505. For <19% styrene content by weight, use the equation: 0.185 × % styrene.
- (4) Including MMA monomer content as supplied, plus any extra MMA monomer added by the molder, but before addition of other additives such as powders, fillers, glass, etc.
- (5) Maricopa County adopted this emission factor based on MMA having a vapor pressure 8 times greater than styrene’s. At 25.5 degrees C, the vapor pressure of MMA is 40 mm of Hg and the vapor pressure of styrene is 5 mm of Hg. To get an emission rate for MMA, this ratio was applied to the emission factor for styrene in marble casting: 0.02 × 8 × % MMA.