

EF Table 1: Unified Emission Factors for Open Molding of Composites

Revised and Approved: 10/13/2009

Emission Rate in Pounds of Styrene Emitted per Ton of Resin or Gelcoat Processed

Styrene content in resin/gelcoat, % ⁽¹⁾	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	>50 ⁽²⁾
Manual	83	89	94	100	106	112	117	123	129	134	140	146	152	157	163	169	174	180	(0.286 x %styrene) - 0.0529) x 2000
Manual w/ Vapor Suppressed Resin VSR ⁽³⁾	Manual emission factor [listed above] x (1 - (0.50 x specific VSR reduction factor for each resin/suppressant formulation))																		
Mechanical Atomized	111	126	140	154	168	183	197	211	225	240	254	268	283	297	311	325	340	354	(0.714 x %styrene) - 0.18) x 2000
Mechanical Atomized with VSR ⁽⁴⁾	Mechanical Atomized emission factor [listed above] x (1 - (0.45 x specific VSR reduction factor for each resin/suppressant formulation))																		
Mechanical Controlled Spray with VSR	86	97	108	119	130	141	152	163	174	185	196	207	218	229	240	251	262	273	0.77 x ((0.714 x %styrene) - 0.18) x 2000
Mechanical Non-Atomized	Mechanical Atomized Controlled Spray emission factor [listed above] x (1 - (0.45 x specific VSR reduction factor for each resin/suppressant formulation))																		
Mechanical Non-Atomized with VSR ⁽³⁾	71	74	77	80	83	86	89	93	96	99	102	105	108	111	115	118	121	124	((0.157 x %styrene) - 0.0165) x 2000
Mechanical Non-Atomized application of resins that contain Methyl Styrene monomer ⁽¹⁰⁾	Mechanical Non-Atomized emission factor [listed above] x (1 - (0.45 x specific VSR reduction factor for each resin/suppressant formulation))																		
Mechanical Non-Atomized Styrene monomer emission Factor (listed above) x .55																			
Mechanical Non-Atomized Filled DCPD resins ⁽¹¹⁾	95	98	101	104	106	111	114	117	120	124	127	130	133	136	140	143	146	149	((0.1603 x % styrene)-0.0055) x 2000
Filament application	122	127	133	138	144	149	155	160	166	171	177	182	188	193	199	204	210	215	((0.2746 x %styrene) - 0.0298) x 2000
Filament application with VSR ⁽⁸⁾	79	83	86	90	93	97	100	104	108	111	115	118	122	125	129	133	136	140	0.65 x ((0.2746 x %styrene) - 0.0298) x 2000
Gelcoat Application	294	315	336	358	377	398	418	438	460	481	501	522	543	564	584	605	626	646	((1.03646 x %styrene) - 0.195) x 2000
Gelcoat Controlled Spray Application ⁽⁶⁾	215	230	245	260	275	290	305	321	336	351	366	381	396	411	427	442	457	472	0.73 x ((1.03646 x %styrene) - 0.195) x 2000
Gelcoat Non-Atomized Application ⁽⁸⁾	198	205	214	223	232	241	250	259	268	278	287	296	305	314	323	332	341	350	(0.4506 x %styrene) - 0.0305) x 2000
Lesser Atomized Gelcoat Application ⁽¹²⁾	229	241	252	264	276	287	299	311	322	334	346	357	369	381	392	404	416	428	((0.5842 x % styrene)-0.07825) x 2000
Covered-Cure after Roll-Out	Non-VSR process emission factor [listed above] x (0.80 for Manual ^{or} 0.85 for Mechanical)																		
Covered-Cure without Roll-Out	Non-VSR process emission factor [listed above] x (0.50 for Manual ^{or} 0.55 for Mechanical)																		

Emission Rate in Pounds of Methyl Methacrylate Emitted per Ton of Gelcoat Processed

MMA content in gelcoat, % ⁽⁶⁾	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	≥20
Gel coat application ⁽⁷⁾	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	0.75 x %MMA x 2000

Table from 30% TO 32% styrene content:

30	31	32
194	208	217

Notes

- 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.
- Formulas for materials with styrene content < 33% are based on the emission rate at 33% (constant emission factor expressed as percent of available styrene), and for styrene content > 50% on the emission rate based on the extrapolated factor equations; these are not based on test data but are believed to be conservative estimates. The value for "% styrene" 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 wt.
- The VSR reduction factor is determined by testing each resin/suppressant formulation according to the procedures detailed in the CFA Vapor Suppressant Effectiveness Test.
- SEE the CFA Controlled Spray Handbook for a detailed description of the controlled spray procedures.
- The effect of vapor suppressants on emissions from filament winding operations is based on the Dow Filament Winding Emissions Study.
- 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.
- Based on gelcoat data from MMA Emission Study.
- SEE the July 17, 2001 EECS report, Emission Factors for Non-Atomized Application of Gel Coats used in the Open Molding of Composites for a detailed description of the non-atomized gelcoat testing.
- Use the equation ((0.4506 x %styrene) - 0.0305) x 2000 for gelcoats with styrene contents between 19% and 32% by wt.; use the equation 0.185 x %styrene x 2000 for gelcoats with less than 19% styrene content by wt.
- Refer to Section 3.0. Instructions and Examples for the Emission Factor table, 3.2 Calculation of the methyl styrene factor
- Use this factor for the non-atomized application of DCPD or DCPD-blend resin, when filled to 30% or more by weight
- Use this factor for the non-atomized application of DCPD or DCPD-blend resin, when filled to 30% or more by weight