LET'S TALK / STYRENE

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STYRENE IN THE SPOTLIGHT

- The European Commission reclassified in July 2014 styrene as CM**R** 2 for Reprotoxicity
  - Industry had to re-label its products by January 1, 2016
  - At present, no change in DNEL values
  - Reclassification will increase discussion on styrene toxicity/ exposure risks
- US National Toxicology Program (NTP) listing as “reasonably anticipated to be human carcinogenic” (June 2011)
- However, in EU styrene is actually not considered a concern for human carcinogenicity

More OEMs/ End-customers are looking for lower styrene and styrene-free solutions

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CMR 2 CLASSIFICATION CAN HAVE PRACTICAL IMPLICATIONS FOR YOU

- Likely stronger control of styrene concentration in workshop and enforcement of styrene Operating Exposure Limits by local authorities
- Legal requirement to investigate alternative raw materials
- Potential modification factory layout/environmental protection systems
- Potential introduction of Personal Protective Equipment
- Increased administrative obligations
- Change in Operating Permit: may need renegotiation with local authorities
- Potentially increased cost of managing process waste

STYRENE EXPOSURE LEVELS

- Styrene REACH Consortium (styrene suppliers) proposed a threshold value for safe use for worker inhalation exposure
- This **D**erived **N**o **E**ffect **L**evel (DNEL) is 20 ppm
- Authorities in EU countries have different **O**perating **E**xposure **L**imits defined for styrene (8-hour Time Weighted Average or TWA)
- Some are below, some are above the DNEL of 20 ppm

Country	8-hour TWA (ppm)
Belgium	50
Czech Republic	24
Denmark	25*
Finland	20
France	23.5**
Germany	20
Italy	20
Netherlands	25
Norway	25
Poland	12
Portugal	20
Spain	20
Sweden	20***
Switzerland	20
United Kingdom	100****

Source: UPR and VER Safe Handling Guide no. 3, Plastics Europe, Nov 2012

* Ceiling limit
** Per January 1, 2019
*** 10 ppm for new installations
**** Obligation to reduce as much as possible

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OPERATING CONDITIONS DIFFER PER APPLICATION METHOD

- Most important workers' exposure to styrene is through inhalation, while skin related exposure is marginal only
- It is predicted from Safe use analysis that styrene levels can be below DNEL of 20 ppm for different composite manufacturing processes
- This means workers can safely work with styrene, but under *specific* Operating Conditions/ using the recommended Risk Management Measures
- Details on Safe Use will be described in the eSDS for the finished products
  - Additional information in the Safe handling guides Cefic-UPR

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STYRENE LEVELS CAN BE BELOW 20 PPM

Process/ Application method	Typical styrene emissions	Styrene <20 ppm possible?	Required Operating conditions/ Risk Management Measures for reaching <20 ppm styrene
Rolling, brushing, etc.	🟡	🟢	Dilution ventilation 70% eff.
Spraying robot or booth	🟢	🟢	NA
Spraying open floor	🔴	🟢	Dilution ventilation 70% eff., half mask
Putties, bonding pastes	🟡	🟢	Dilution ventilation 70% eff.
Continuous open processes	🟡	🟢	Local Exhaust Ventilation (LEV) 90% eff.
Casting, SMC manufacturing	🟡	🟢	Dilution ventilation 90% eff. Local Exhaust Ventilation (LEV)
Blending, formulating	🟡	🟢	Dilution ventilation
RTM, vacuum infusion, sewer relining	🟢	🟢	NA
High temperature curing	🟡	🟢	Dilution ventilation 90% eff. Local Exhaust Ventilation (LEV)

🟢 < 20 ppm 🟡 50 ppm 🔴 250 ppm

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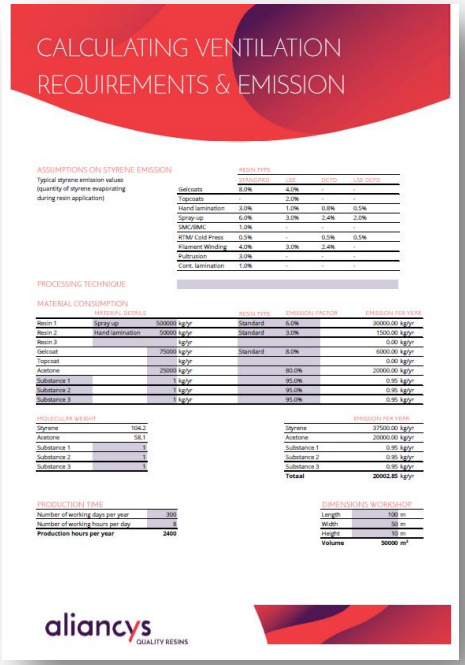
EMISSION MODEL FOR DISCUSSIONS WITH ALIANCYS CUSTOMERS

- Provides additional insight to our customers on the complicated issue of styrene emissions
- Helps customer to define need for emission control equipment and ventilation
- Helps customer to prepare for obtaining operating permits/ address questions during inspections
- Helps to better show the value of low styrene and styrene-free resins



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SUSTAINABLE ALTERNATIVES THAT LAST

- Aliancys believes styrene is safe to use
  - Provided worker exposure level is below the limits accepted in the industry
- Consequently Aliancys will continue to develop and sell resins based on styrene
- Clear interest OEMs/ end customers for styrene-free
- Therefore Aliancys will work hard on developing novel styrene-free portfolio

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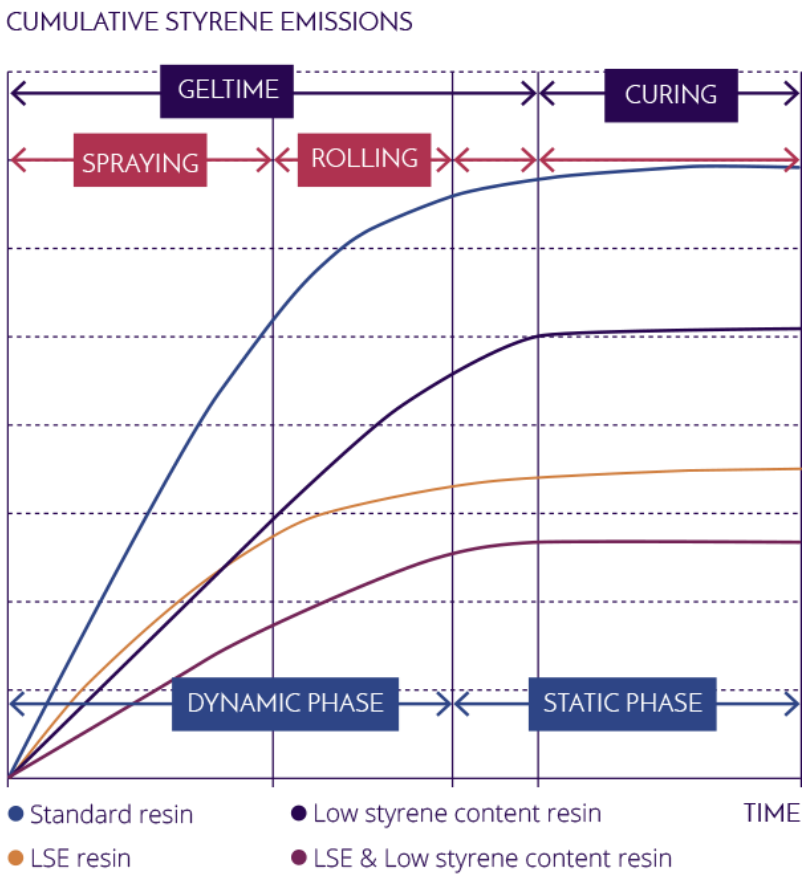
HOW TO REDUCE STYRENE EMISSIONS?

- Cleaner processing and good housekeeping
  - Avoid open resin buckets and pails
- Reduce workshop temperature
  - Ensure temperatures are above recommended resin cure temperatures
- Introduce Low Styrene Emission (LSE) resins
- Introduce resins with lower styrene content and zero-styrene resins
- Switch to closed mold processing where possible

THE POSITIVE EFFECT OF USING LSE RESINS ON STYRENE EMISSIONS



Modeled after: UPR and VER Safe Handling Guide no. 6, Plastics Europe, Nov 2012

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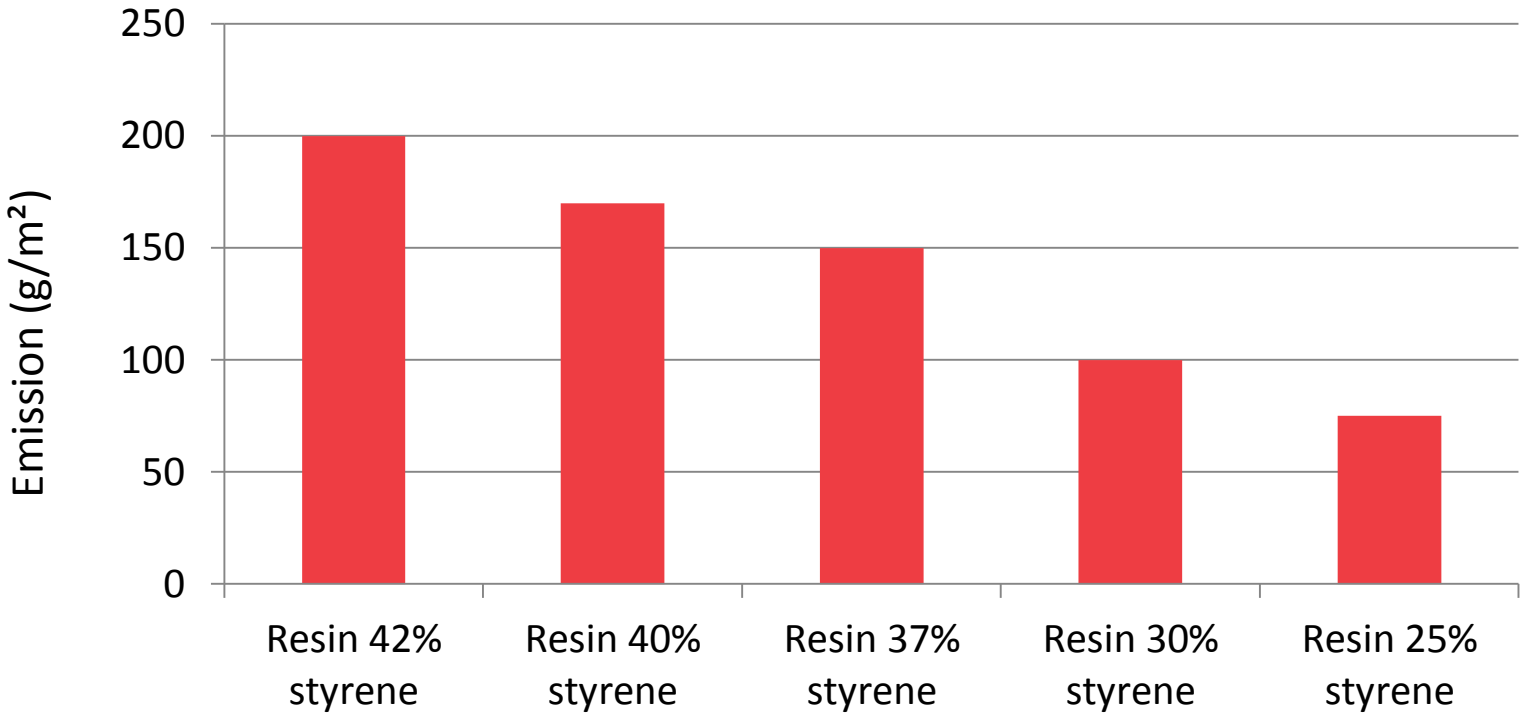
CLEAR INFLUENCE STYRENE RESIN CONTENT ON DYNAMIC STYRENE EMISSION (AVK METHOD)



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ATLAC® PREMIUM 100, 600

STYRENE-FREE RESINS

Property	Test Method	Atlac® Premium 100	Atlac® Premium 600
Viscosity 23°C (mPa.s)	TM 2013	420-520 (100 s^{-1})	850-100 (250 s^{-1})
Gel time (s)	TM 2625	16-24	14-20
Peak time (s)	TM 2625	18-27	21-33
Peak temperature (°C)	TM 2625	127-156	110-175
Flash point (°C)	TM 2800	113	113
Appearance	TM 2265	Clear-sl. Hazy	Hazy
Tensile strength (MPa)	ISO 527-2	61	66
Tensile elongation (%)	ISO 527-2	2.4	2.5
HDT (°C)	ISO 75A	101	103

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BEYONE™ 805-N-01, BEYONE™ 806-H-01

STYRENE-FREE RESIN SYSTEM - LIQUID RESIN PROPERTIES-

Property	Test Method	Beyone™ 805-N-01	Beyone™ 806-H-01
Viscosity s-1/23°C (mPa.s)	TM 2013	2,000-2,500	2,800-3,800
Acid numbers (mg KOH/g)	TM 2033	14-20	2-6
Cure time (s)	TM 2261	50-80	-
Peak time (s)	TM 2261	75-115	-
Peak temperature (°C)	TM 2261	210-230	-
Water content (%)	TM 2350	0.05-0.15	0.14-0.30
Appearance	TM 2265	Clear-sl. hazy	Clear-sl. hazy

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ZERO STYRENE RESINS FROM ALIANCYS

COMBINING END-USE PERFORMANCE AND SUSTAINABILITY

- Styrene-free solutions for main applications with proven end-use performance
- Better working environment for your workers
  - Reduced need for Personal Protective Equipment
  - Healthier workshop with less smell
- Simplification of operational permit process
  - More efficient management of increasingly stricter regulations
- Lower investments for newly built workshops
  - No need for costly ventilation equipment
- Increased acceptance of works in residential areas
  - Avoiding styrene odour and associated public concerns

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