



Assessing and controlling styrene levels during contact moulding of fibre-reinforced plastic (FRP) products

Plastics Processing Sheet No 14

Introduction

This information sheet was produced by the Health and Safety Executive (HSE) in consultation with the Plastics Processors' Health and Safety Liaison Committee (PPHSLC). The Committee includes HSE and representatives of employers and employees in the plastics industry.

This sheet summarises the health hazards that can arise from exposure to styrene. It also provides practical guidance to FRP manufacturers on how to assess and control styrene levels in the workplace and how these control measures should be monitored and maintained in accordance with the Control of Substances Hazardous to Health Regulations 2002.¹ It applies mainly to contact moulding processes.

It does not address the control of emissions of air and odour to the external environment which are regulated by the Pollution Prevention and Control Act 1999 and previous legislation. Depending on your location, you should contact your Local Authority or the Scottish Environment Protection Agency for details of current Process Guidance Notes relating to styrene.

A related information sheet (PPS15) *Reducing the risk of fire or explosion during the manufacture of fibre-reinforced plastic (FRP) products* deals with precautions in respect of fire and explosion risks during FRP manufacturing.

Health hazards and legal requirements

Styrene vapour can cause irritation to the nose, throat and lungs. Neurological effects include difficulty in concentrating, drowsiness, headaches and nausea. The vapour and splashes are also irritating to the eyes and skin.

It is not possible to specify a 'safe' level to which employees can be exposed without a risk to their health. The maximum exposure limit (MEL) for styrene is currently 100 parts per million (ppm) averaged over an 8-hour day. There is also a short-term exposure limit (STEL), currently 250 ppm averaged over a 15-minute period. These levels apply at April 2003 (see HSE guidance book EH40 *Occupational exposure limits* for the latest levels).

There is a legal obligation to control exposure to styrene to a level which is as low as reasonably practicable below the MEL. This sheet aims to define what level of control is currently recognised as being reasonably practicable.

Controlling exposure

Assessing the risk

The measures needed to control vapour levels are dependent on the scale of the manufacturing process and the nature of the articles being produced. The main factors involved are:

- whether you spray lay-up or do it by hand;
- whether you use a non-atomising spray gun or not;
- whether you use low-styrene-emission/content resins or not;
- for hand lay-up operations, the position of the head in relation to the brush or roller;
- whether you are gel coating or not;
- the amount of resin you use on a typical day;
- the number of hours for which laminating is done;
- the size, shape and surface area of the moulding;
- the curing rate; and
- the size of your workroom or area.

Match your own patterns of work to the closest option in each section of Table 1 and add your scores together. The total will give you a figure which should then be matched to 'action required' (see Table 2) to decide what levels of control are needed. (NB Where moulding size is highly variable, make sure that what you provide reflects the 'worst case' likely to occur.)

Action required

The measures in Table 2, will, in nearly all situations, be enough to control the 8-hour time-weighted average exposure to the level currently recognised as being as low as is reasonably practicable.

Monitoring and maintaining control measures

Once you have put in place your control measures, you need to maintain them and monitor their continued effectiveness. Table 3 summarises the initial checks you will need to make when setting up such a system

Table 1 Scoring system to be used to determine the level of control needed

<i>Process</i>			
Hand lay-up or spray lay-up with non-atomising spray gun*	1	Spray lay-up with atomising spray gun*	3
<i>Processing stage</i>			
Not gel coating	1	Gel coating	2
<i>Rate of resin use**</i>			
Resin use 5 kg/worker/hour or less	1	Resin use 6-10 kg/worker/hour	2
Resin use 11-15 kg/worker/hour	3	Resin use more than 15 kg/worker/hour	5
<i>Daily exposure</i>			
Exposure up to 4 hours/day	1	Exposure over 4 hours/day	3
<i>Moulding shape and size</i>			
Mouldings flat, up to 1 m ²	1	Mouldings flat, over 1 m ²	2
Mouldings deeply concave or convex	3	Mouldings with bulkheads/enclosed areas	5
<i>Workroom size</i>			
Large workroom over 5000 m ³	1	Medium workroom 500-5000 m ³	2
Small workroom up to 500 m ³	3		

* Due to the flammability of the resin and the rate of use, spray lay-up should normally be done in a purpose-built spray booth unless the article is too large.

** The 'Rate of resin use' part of the table assumes that low-styrene-emission resins (sometimes called 'environmental' resins) are used. These, or low-styrene-content resins, should always be used where possible. **Where they are not used, the 'Rate of resin use' figure should be doubled.**

Table 2 Control measures to take according to the score from Table 1

<i>Score from Table 1</i>	<i>Ventilation specification</i>	<i>Other measures</i>
6-8	You will need to provide good general ventilation, sufficient to change the air at least five times per hour. This means providing a fan to draw in fresh air at one end of the workroom, and a fan at the opposite side at ground level to remove any styrene-laden air.	Replace lids on containers and drums when not actually in use. Organise the work as far as possible so that workers do not impede ventilation airflow and work towards the 'extract' end of the workroom. Provide and ensure the use of suitable gloves, selected on the advice of resin and glove suppliers. Use rollers with splash guards to control droplets.
9-14 and no individual box score of 5	As well as the general ventilation described in the 'Score 6-8' section, you will need to provide local exhaust ventilation (LEV)* close to the work being done. This can be in the form of flexible trunking which should be adjusted to be as close to the moulding surface as possible. To be effective, it should be within 200 mm of the work surface (or 300 mm of the base of a concave moulding), and should be flanged for maximum directional effect.	Follow the 'Other measures' in the 'Score 6-8' section to reduce exposure.
15 or more or any individual box score of 5	Work in this category is likely to lead to high exposure unless very carefully controlled. In some cases (spray lay-up), work in a purpose-built spray booth will almost always be necessary. For work inside large mouldings where it is difficult to use LEV, or where LEV on its own may not be sufficient, 'push-pull' ventilation* should be used to move styrene-laden air through the moulding towards extract ventilation.	You may need to supplement ventilation with respiratory protective equipment ² or, in exceptional cases, use airline-fed equipment to ensure workers are not over-exposed.** Seek specialist advice on these matters.

* Such systems should be designed by a competent ventilation engineer who can factor in all the relevant requirements such as those for make-up air, balancing against existing systems and heating needs, and room capacity. Detailed requirements for LEV design can be found in *An introduction to local exhaust ventilation*.³

** In this situation, the work may also need to comply with the Confined Spaces Regulations 1998.

and your statutory duties for monitoring and maintaining these arrangements under the Control of Substances Hazardous to Health Regulations 2002.

The detail and frequencies for some of these duties are specified in the Regulations. For less specific requirements see Table 3 which includes recommendations on how and when those that require discretion or judgement can be met. Remember to keep records of any testing and examinations.

You can either adopt these recommendations in this information sheet as they stand, or develop your own specification based on a risk assessment which, as a minimum, will involve measurement of actual styrene exposure levels.

Health surveillance

Detailed health surveillance should not normally be necessary, however, a monitoring programme incorporating measurement of urinary Mandelic acid (MA) or phenylglyoxylic acid (PGA) may be useful to determine the effectiveness of control measures, especially if used before and after a new control measure is introduced or existing controls are modified.

If skin contamination is an issue in your factory, a responsible person should be nominated to ask questions and conduct visual inspections of hands and forearms. See the 'Further reading' section for guidance on skin care programmes.⁴

Other information

The above method of estimating levels of styrene may not always be appropriate for work in tanks or where the shape of the mould will result in 'pockets' of styrene accumulating where workers are applying resin. In these circumstances, levels of styrene should be measured to assess exposure if airline-fed breathing equipment is not used.

Further reading

- 1 *Control of substances hazardous to health. The Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance L5* (Fourth edition) HSE Books 2002 ISBN 0 7176 2534 6
- 2 *The selection, use and maintenance of respiratory protective equipment: A practical guide HSG53* (Second edition) HSE Books 1998 ISBN 0 7176 1537 5
- 3 *An introduction to local exhaust ventilation HSG37* (Second edition) HSE Books 1993 ISBN 0 7176 1001 2
- 4 *Choice of skin care products for the workplace: Guidance for employers and health and safety specialists HSG207* HSE Books 2001 ISBN 0 7176 1825 0
- 5 *Health risks management: A guide to working with solvents HSG188* HSE Books 1998 ISBN 0 7176 1664 9

Further information

HSE priced and free publications are available by mail order from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 2WA Tel: 01787 881165 Fax: 01787 313995 Website: www.hsebooks.co.uk (HSE priced publications are also available from bookshops and free leaflets can be downloaded from HSE's website: www.hse.gov.uk.)

For information about health and safety ring HSE's Infoline Tel: 08701 545500 Fax: 02920 859260 e-mail: hseinformationservices@natbrit.com or write to HSE Information Services, Caerphilly Business Park, Caerphilly CF83 3GG.

This leaflet contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.

© *Crown copyright* This publication may be freely reproduced, except for advertising, endorsement or commercial purposes. First published 08/03. Please acknowledge the source as HSE.

Table 3 Suggested checks for ensuring control methods used remain effective

	<i>Initial checks</i>	<i>Daily</i>	<i>Monthly</i>	<i>Annually</i>
Ventilation	Air is being moved away from the operator. The system is the right size and design for the work. The supplier has indicated how often filters on spray booths should be replaced.	Check that ventilation hoods are adjusted properly and the ductwork is neither damaged nor blocked.	Carry out a smoke test.* Replace filters (or at frequency advised by suppliers).	Test and thorough examination in accordance with COSHH Regulations.
Rollers with splash guards	Splash guards have been provided.	Check that splash guards are in place and effective.		
Gloves/skin inspection	Viton or Butyl gloves have been provided for lay-up work during which hands become contaminated. Suppliers have advised the frequency at which gloves should be changed.	Check that gloves are being worn and are in good condition.	Replace (or at frequency advised).	
Respiratory protective equipment (RPE)	The appropriate protective equipment is specified for each job. The frequency for changing filters is specified.	Check that RPE is used where specified and carry out a visual check that the equipment is in good condition.	Thorough examination of RPE.	
Material storage	Non-spill containers are provided for working areas.	Bulk drums are lidded and those not in use are removed to store.		
Air monitoring	Specify frequency if anything other than annual.			Monitor exposure and improve controls as necessary and record results.

* This can be done using commercially available smoke tubes. Smoke tubes are a useful way of making a qualitative assessment of the airflow patterns in the work area. In simple terms, if the smoke is generated near the source of the styrene vapours and it is immediately seen to move towards the ventilation hoods, canopies and slots etc, then it is likely that any styrene vapours being generated are being effectively captured. If, however, the smoke is seen to disperse in the area and not move in any particular direction, then it suggests that the ventilation system is not effectively capturing the vapours being generated.