

Reducing the risk of fire or explosion during the manufacture of fibre-reinforced plastic products

HSE information sheet

Plastics Processing Sheet No 15 (Revision 1)

Introduction

This information sheet is one of a series produced by HSE's manufacturing sector. It applies to those who manufacture fibre-reinforced plastic (FRP) products. The manufacturing process uses substances which are classified as dangerous – eg flammable liquids and peroxides – which means they have the potential to give rise to fires and explosions which can affect the safety of employees and others.

Hazards

In any laminating workshop, there are a number of materials which pose a significant fire risk and, given the correct circumstances, the risk of an explosion. Examples include:

- Catalysts often contain peroxides. Peroxides can auto-decompose to generate large amounts of heat, and under certain circumstances can also auto-ignite. They contain 'free' oxygen so can burn intensely even in the absence of air. A small fire can therefore rapidly get out of control and is difficult to fight.
- Most resins are pre-accelerated, but if you add your own accelerator it is usually supplied in a solvent carrier such as toluene, which is highly flammable.
- Styrene¹ and acetone have low flashpoints and therefore present a significant fire risk if not properly controlled. Acetone is a greater hazard than styrene because it ignites more easily. Any flammable material ignited in a confined space can cause an explosion. Explosive atmospheres can exist during routine activities if the workspace is not adequately ventilated.
- Dust released during trimming of mouldings is combustible. A 'cloud' of combustible dust can also cause an explosion if ignited.

There are five general principles for ensuring that the risks of fire and explosion from the storage of flammable liquids in containers are controlled and minimised:

- **Ventilation:** Is there plenty of fresh air where containers are stored?

- **Ignition:** Have all the ignition sources been removed from the storage area?
- **Containment:** Are the flammable liquids stored in suitable containers? Can any spillage be contained?
- **Substitution:** Can you exchange a flammable liquid for a less flammable one?
- **Separation:** Are flammable liquids stored well away from other processes and general storage areas?

Assessments

As there are fire and explosion risks associated with this process the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002² will apply. DSEAR requires a risk assessment which should initially consider whether any of the dangerous substances can be eliminated, but where this is not possible the risks should be controlled so far as is reasonably practicable. Substitution should be considered so that dangerous substances are replaced with alternatives which reduce the risk, eg the replacement of acetone by a water-based substitute for the cleaning operations.

The DSEAR pages on HSE's website provide further information about how to carry out a DSEAR assessment (see Further reading). Where there are five or more employees the significant findings of the assessment should be recorded.

Control measures

Detailed below are some examples of control measures that should be put in place during the manufacture of FRP. This list of control measures should not be seen as exhaustive and additional control measures may be required.

Storage of catalysts

The quantity of catalyst, eg methyl ethyl ketone peroxide, stored should be kept to a minimum and in the original packaging. The catalyst should be kept in a dedicated store separately from other flammables, eg acetone, resins and accelerators. Some organic

peroxide catalysts may need to be kept within predetermined temperature limits which are related to the self-accelerating decomposition temperature (SADT). The SADT is on the material safety data sheet (MSDS) for the catalyst.

Where quantities of organic peroxide catalyst exceed 150 kg a separate concrete bunker should be used which is bonded to contain 110% of the maximum stored quantity.

Find further detailed guidance on the storage of organic peroxide catalysts in *Storage and handling of organic peroxides*.³

Storage of flammables

The accelerators, eg cobalt in toluene, acetone and resins containing styrene, are all classified as flammables.

These substances should be stored in a suitable fire-resisting store or outside. Further detail about the storage of materials and the need for any further separation and segregation is in these HSE publications.^{4,5,6,7,8}

Production

The quantities of materials used in the production area should be kept to a minimum and materials returned to the storage areas immediately after use. Only trained and competent people should handle the materials in use.

Steps should be taken to avoid or minimise the release of flammable materials at source, eg the use of fully sealable lidded containers for brush-soaking in acetone, closing containers for catalysts immediately after use and, where small quantities of liquids are required, the use of small proprietary dropper type containers. Spatulas, jugs and ladles should be kept free from contamination so flammable materials are not released locally. To further avoid the release of flammable vapours, accelerators with as high a flashpoint as possible should be used.

Where the release cannot be avoided it should be controlled at source, eg by providing local exhaust ventilation (LEV) in the working area. LEV should also be provided in confined areas, eg inside boat hulls to prevent the build-up of flammable vapours.

Where flammable vapours are released, adequate ventilation should be provided in the work area to prevent the formation of an explosive atmosphere. The ventilation system should exhaust to a safe place in the open air away from building openings, boundaries and sources of ignition.

The DSEAR assessment will determine the amount of ventilation required to ensure explosive atmospheres are prevented. See Further reading.

Ignition sources

Ignition sources should be avoided in all areas where flammable materials are handled. This includes electrostatic discharges.

Areas where flammable materials are stored and used should be classified into zoned areas; for vapours these will be zones 0, 1 and 2. A competent person should determine the extent of the zoned areas (see BS EN 60079-10-1:2009).⁹ Once the zoned areas are defined the type of equipment that can be used within them can be selected. The fan motors used in the LEV should be suitable for use with flammable vapours, eg flameproof motors or bifurcated fans can be used. For more information on hazardous area classification and control of ignition sources see Further reading.

Other ignition sources should also be eliminated, eg hot surfaces and friction from mechanical sources.

Static discharges should be prevented, eg suitably conductive earthing clips should be used on all metal containers and operators should wear suitable conductive footwear.

Dust

Combustible dusts can be generated during the process, eg trimming, sawing and drilling. Dust generation should be avoided and, where this is not possible, minimised and controlled. Similar control measures should be applied to the generation of dust, as above. Different operations generate differing amounts of dust, eg disc sanding generates more dust than sawing or cutting. Operations should be selected to minimise the amount of dust generated.

Where the generation of dust cannot be avoided LEV should be provided to prevent the formation of an explosive dust atmosphere. The type of LEV required will depend on the size of workpiece, eg where small workpieces are trimmed extracted trimming equipment may be sufficient, but for larger mouldings, typically over 2 m³, a trimming booth may be required.

Similar to flammable vapours, areas where combustible dusts are handled should also be classified into zones; for dusts these are zones 20, 21 and 22 (see BS EN 60079-10-2:2009).¹⁰ The electrical equipment in use in these zoned areas should be designed so that it is suitable for use with combustible dusts, eg flameproof motors in the LEV.

When clearing dusts, brushing and air blowing should be prohibited.

Vacuum cleaners used to remove dusts from floors and surfaces should be suitably designed so that they can be used with combustible dusts.

Dust extraction units should be maintained in good working order to ensure dust is not discharged into the workplace. Suitable explosion relief should be fitted to the dust extraction and collection unit and the explosion relief should be designed by a competent person.

Spillage, recovery and disposal

The floor covering used where FRPs are handled should be of a non-slip type, eg hardboard; other coverings may also be used, such as robust polypropylene sheet, but consideration should be given to whether it introduces a slip hazard.

Spillages should be removed immediately. Use sand and vermiculite not organic materials such as paper or cloth.

Waste catalysts should not be put into skips containing cardboard, natural organic materials or rusty drums.

Empty drums should be stored as for full drums as they will contain flammable vapours (unless they have been properly cleaned and washed out).

Empty drums should not be used as trestles or workstands.

Rags soaked in solvent should be disposed of in metal bins with self-closing lids.

Solvent recovery

Solvent recovery should only be carried out by trained, competent personnel using suitably designed equipment.

Acetone should be recovered into suitable metal containers, eg dedicated steel solvent-recovery containers. Reclaimed catalyst containers should not be used for recovered acetone as there can be a violent reaction between acetone and the peroxides often found in catalysts.

Maintaining control measures

When the control measures described above are in place arrangements will need to be made to ensure they are maintained. The checks and frequencies detailed below provide some examples of what can be included in a maintenance system, although the list should not be viewed as exhaustive. The items should be amended and refined in the light of experience.

Some examples of daily checks include:

- Have all containers of resins, acetone, catalyst and accelerator been properly sealed and returned to the correct store after use?
- Have all spillages been removed and is there a sufficient supply of spillage absorber?
- Check dispenser bottles for damage and replace as necessary.
- Check brushes are not left in open containers, nor in containers that will spill easily if knocked over.
- Have all empty containers been returned to the correct store to await collection?
- Check there are no catalyst containers outside the mixing area.
- Check no catalyst containers have been put into general rubbish skips.
- Check all fire exits are clear, particularly those from inside boat hulls and other large workpieces that people may work inside.

Some examples of monthly checks include:

- Are all stores properly marked up, properly used and in good condition?
- Check dropper containers are not seeping.
- Check there is no inappropriate electrical equipment or other potential sources of ignition in zoned areas.
- Is extraction working properly on equipment to remove dust? (This is also a legal requirement if dust is a health hazard.¹¹)

Additional statutory checks may have to be made, eg to the LEV

Even when all the control measures are in place there is a residual risk of fire and explosion in the workplace. Employers should take steps to mitigate the effects of a fire or explosion, eg:

- Keep the number of people present in the workplace to a minimum.
- Avoid the spread of fires. Carry out work activities in separate rooms which are fire separated from the storage areas. Fire then cannot spread easily from the manufacturing area to the storage area.
- Provide suitable explosion relief to dust collection units or solvent-recovery systems.

Also see Further reading. Further mitigation measures can be found in *Safe use and handling of flammable liquids* and the DSEAR Regulations.

References and further reading

References

1 *Styrene control in fibre-reinforced plastics contact moulding* Plastics Processing Information Sheet PPI14(rev1) HSE Books 2015
www.hse.gov.uk/pubns/ppis14.htm

2 *Dangerous substances and explosive atmospheres: Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance* L138 (Second edition) HSE Books 2013 www.hse.gov.uk/pubns/books/l138.htm

3 *Storage and handling of organic peroxides* Chemical Safety Guidance Note CS21 HSE Books 1991 www.hse.gov.uk/pubns/books/cs21.htm

4 *Storage of flammable liquids in containers* HSG51 (Third edition) HSE Books 2015
www.hse.gov.uk/pubns/books/hsg51.htm

5 *Chemical warehousing: The storage of packaged dangerous substances* HSG71 (Fourth edition) HSE Books 2009
www.hse.gov.uk/pubns/books/hsg71.htm

6 *Safe use and handling of flammable liquids* HSG140 (Second edition) HSE Books 2015
www.hse.gov.uk/pubns/books/hsg140.htm

7 *Storage of flammable liquids in tanks* HSG176 (Second edition) HSE Books 2015
www.hse.gov.uk/pubns/books/hsg176.htm

8 *The spraying of flammable liquids* HSG178 HSE Books 1998
www.hse.gov.uk/pubns/books/hsg178.htm

9 BS EN 60079-10-1 *Explosive atmospheres: Classification of areas – Explosive gas atmospheres* British Standards Institution

10 BS EN 60079-10-2 *Explosive atmospheres: Classification of areas – Combustible dust atmospheres* British Standards Institution

11 *Control of substances hazardous to health (COSHH). The Control of Substances Hazardous to Health Regulations 2002 (as amended). Approved Code of Practice and guidance* L5 (Sixth edition) HSE Books 2013 www.hse.gov.uk/pubns/books/l5.htm

Further reading

For health and safety in plastics manufacturing premises see HSE's plastics webpages www.hse.gov.uk/plastics/

Safe handling of combustible dusts: Precautions against explosions HSG103 (Second edition) HSE Books 2003
www.hse.gov.uk/pubns/books/hsg103.htm

Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996 SI 1996/192 The Stationery Office
www.legislation.gov.uk

Guidance. Fire safety risk assessment: Factories and warehouses 2006 www.gov.uk/government/publications/fire-safety-risk-assessment-factories-and-warehouses

For information on carrying out a DSEAR assessment www.hse.gov.uk/fireandexplosion/dsear.htm

COMAH: Technical Measures Documents
www.hse.gov.uk/comah/sragtech/techmeasindex.htm

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

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