

# Fire and explosion risks from pentane in expandable polystyrene (EPS)

## HSE information sheet

## Plastics Processing Sheet No 1 (Revision 1)

### Introduction

This information sheet is one of a series produced by HSE's manufacturing sector. Its purpose is to give guidance on managing the fire and explosion risks from pentane during unloading, storing and using expandable polystyrene bead (EPS). It is aimed at those who use, store or unload EPS. The main legal requirements covering the fire and explosion risks are in the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR 2002)<sup>1</sup> and the supporting Approved Code of Practice (ACOP).<sup>2</sup>

Raw EPS contains a flammable gas, usually pentane. Pentane is extremely flammable. Its flash point is minus 50 °C and its boiling point 36 °C. It is heavier than air and odourless. As it is heavier than air the vapour given off can collect in low-lying areas or containers and create a persistent flammable atmosphere, which if ignited can cause a flash fire. Some pentane is given off all the time the material is being stored and transported, and will even be released from finished products for a short while after manufacture.

EPS is normally delivered in containers designed to reduce the amount of pentane given off, however some pentane may leak from packaging. The amount given off will increase when packages are opened ready for production.

As a result of the fire and explosion risks DSEAR 2002 will apply. You will need to carefully consider whether you have to use EPS rather than a safer material and, if you do, whether you have identified the risks and appropriate control and mitigation measures to reduce the risks. The supplier's safety data sheet (SDS) will also be helpful in identifying precautions you will need to take. For more information on DSEAR 2002 and how to carry out a DSEAR assessment see [www.hse.gov.uk/fireandexplosion/dsear.htm](http://www.hse.gov.uk/fireandexplosion/dsear.htm).

A number of regulations have a requirement to carry out a risk assessment and record your findings if you employ five or more people. You may decide to merge some or all of these assessments together and produce combined risk assessments, eg DSEAR

could be included with general fire precautions risk assessments completed for the Management of Health and Safety at Work Regulations or other fire-specific legislation. You can decide the best way of doing the assessments for your workplace. Where you need to record the findings of the assessment in writing it should be a concise and useful working tool that you can work through, update and review.

### Hazards and precautions

Here are seven essential things you should know about pentane in EPS bead, *however you handle or use it*. You should consider these in your DSEAR assessment of the storage and use of EPS in your workplace:

- Pentane will ignite if it comes into contact with any surface with a temperature that exceeds 285 °C, eg a light bulb. All potential ignition sources (including electrostatic sources) need identifying and controlling.
- Smoking must be prohibited anywhere EPS bead is used or stored.
- Unsuitable temporary heating appliances used in winter can present an ignition risk where EPS bead is stored. You should check any appliances you find to ensure they are suitable for the area.
- Energy from temporary electrical wiring and the use of portable electric tools can ignite pentane. Avoid the first, and allow the second only under controlled conditions.
- Check that electrical switches, ventilation fans etc are suitable for use where flammable vapours of pentane can occur.
- Use of a gas monitor will enable you to identify where pentane 'hot spots' are likely to occur, and to measure concentrations.
- There is no difference in pentane risk between flame-retardant and regular EPS.

To reduce the risk of fire and explosion from the release of flammable gas from the EPS, control measures should be put in place. All aspects of work with EPS should be included when considering the risks, eg delivery, storage, processing, moulding and

storage of finished goods. The DSEAR assessment should consider whether the risks from pentane in EPS bead can be eliminated. Only put in place control measures where this is not reasonably practicable.

There are many areas where a flammable atmosphere is likely to occur when storing, processing and handling EPS. Where these flammable atmospheres are likely to occur, the control of ignition sources is necessary. Areas where a flammable atmosphere is likely to exist should be classified into zones; for vapours this would be a zone 0, 1 and 2. The extent of the zoned area should be determined by a competent person. Once the extent of the zoned area is defined in all three dimensions you can determine the type of equipment that can be used within it. (See BS 60079-10-1:2009.<sup>3</sup>)

Detailed below are some examples of control measures that should be considered when handling and processing EPS. These examples do not provide an exhaustive list and additional control measures may be required.

## Delivery

Information about the properties of EPS will be found on the supplier's SDS.

Offloading should be carried out in a well-ventilated area; it may be prudent to leave the containers or trucks open before unloading to allow any accumulated pentane to disperse. All ignition sources should be excluded from areas where the EPS is handled; this will include smoking.

## Storage

### General

EPS will continue to emit pentane vapour in factory storerooms. Therefore, areas where EPS containers and pre-foam are stored should be well ventilated. Pentane vapour is heavier than air so good low-level ventilation should be provided to ensure that any vapour does not accumulate. You should consider if mechanical ventilation using fans is required.

### Pre-expansion

At this stage, pentane vapour being given off will be mixed with steam which will reduce its flammability, but pentane/steam vapour should still be vented to outside because of the residual risk.

## Maturing silos

EPS can be matured in silos which can be constructed of fabric or metal. When stored in the silo the EPS is likely to continue to give off pentane so there is the potential for an explosive atmosphere to form. Tests carried out by HSE have shown that explosive mixtures can be generated in the head space of maturing silos. In *fabric* silos you should:

- use natural fabrics or conductive fabrics in earthed structures;
- provide and use a gas detector<sup>4</sup> (either a permanently installed detector or a portable one for periodic sampling use, as appropriate);
- ventilate at low levels around the silos using a ventilation type and positioning based on sampling results.

In *metal* silos you should:

- ventilate to keep levels of pentane below the lower explosive limit (LEL) – see the supplier's data sheet;
- ensure that they are robust and fitted with explosion relief, venting to a safe place on the top;
- ensure that they are earthed;
- provide and use a gas detector (as described above).

## Conveying ducts

The risk is higher when the beads are drier, but *in all cases* there is a real risk of fire from static electricity. So you should make sure that:

- all parts of the ducting, including flexible sections, are earth bonded and that there is earth continuity in all ducting;
- product is conveyed at the lowest speed possible.

## Moulding

Steam is introduced during this process, which reduces the fire/explosion risk. However, after moulding, the blocks dry out and will release some pentane vapour. So make sure that there is sufficient general ventilation at low level.

## Cutting and shaping

Hot-wire cutting or laser cutting is known to cause fires. So make sure that you:

- cool exposed wires by forced draught ventilation;
- interlock the block transport system so that if the conveyor stops, the electrical supply to the wire or laser cuts out;

- provide electrical fault detection to prevent wires running red hot and check it regularly;
- never leave a machine during cutting and if excessive flaring occurs turn the machine off;
- have carbon dioxide/dry powder extinguishers available and people trained in their use.

## Finished goods

Pentane can still be given off from finished goods. So make sure that you:

- treat finished goods stores as a fire risk area;
- closely control hot work;
- keep other combustibles away;
- keep finished goods in a well-ventilated place after moulding.

## Recycling of in-house waste

Flammable vapour can still be given off. So make sure that you:

- keep scrap in a well-ventilated storeroom.

## Hot work

Hot work on plant, which includes grinding and cutting with power tools, can provide a source of ignition. Residual heat from such work can even cause ignition some time after the hot work has finished. So make sure that you:

- control any hot work, for example by using a permit-to-work system in areas where pentane is likely to accumulate;
- keep the area clear of anything that could catch fire.

It is also good practice to keep the area under observation for potential fire for an hour or so after the work has finished.

## Planning in advance

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; for example:

- Minimise the number of people present in the workplace.
- To avoid the propagation 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.

Further mitigation measures can be found in the DSEAR ACOP.

The company is also responsible for completing a fire risk assessment for their premises as required by The Regulatory Reform (Fire Safety) Order 2005 RR(FS)O<sup>5</sup> (or Fire (Scotland) Act 2005<sup>6</sup>).

The fire risk assessment should include, for example, measures to reduce the risk of fire and the risk of spread of fire on the premises and measures in relation to the means of escape from the premises.

Further guidance about completing a fire risk assessment is available.<sup>7</sup>

Where there are five or more employees the significant findings of the fire risk assessment should be recorded.

## References

- 1 *Controlling fire and explosion risks in the workplace: A brief guide to the Dangerous Substances and Explosive Atmospheres Regulations* Leaflet INDG370(rev1) HSE Books 2013  
[www.hse.gov.uk/pubns/indg370.htm](http://www.hse.gov.uk/pubns/indg370.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](http://www.hse.gov.uk/pubns/books/l138.htm)
- 3 BS EN 60079-10-1 *Explosive atmospheres. Classification of areas. Explosive gas atmospheres* British Standards Institution
- 4 *The selection and use of flammable gas detectors* HSE Books 2004  
[www.hse.gov.uk/pubns/gasdetector.pdf](http://www.hse.gov.uk/pubns/gasdetector.pdf)
- 5 *The Regulatory Reform (Fire Safety) Order 2005* SI 2005/1541 The Stationery Office  
[www.legislation.gov.uk](http://www.legislation.gov.uk)
- 6 *Fire (Scotland) Act 2005* Act of the Scottish Parliament 2005 asp5 [www.legislation.gov.uk](http://www.legislation.gov.uk)
- 7 *The Fire Precautions (Workplace) Regulations 1997* SI 1997/840 The Stationery Office  
[www.legislation.gov.uk](http://www.legislation.gov.uk)

## Further reading

*Guide to fire safety in factories and warehouses 2006*  
Available from [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/14882/fsra-factories-warehouses.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/14882/fsra-factories-warehouses.pdf)

For general guidance on managing the risks of fire and explosion in workplaces  
[www.hse.gov.uk/fireandexplosion/index.htm](http://www.hse.gov.uk/fireandexplosion/index.htm)  
For more information on health and safety in plastics manufacturing premises [www.hse.gov.uk/plastics/](http://www.hse.gov.uk/plastics/)

## Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit [www.hse.gov.uk/](http://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.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

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