Controlling fume during plastics processing

Plastics Processing Sheet No 13

Introduction

This information sheet was produced by the Health and Safety Executive in consultation with the Plastics Processors Health and Safety Liaison Committee. This Committee comprises the Health and Safety Executive, employers and employee representatives in the plastics industry.

This sheet provides advice on how to control plastic fume during moulding, extrusion and similar processes. It emphasises the need to reduce fume formation by maintaining plant and following recommended processing parameters such as temperature and residence/dwell time.

It is important to remember that incorrect melt temperatures or residence times can result from not appreciating the true nature of the material being processed, which can cause unexpected fume problems. This can arise where there is new material being used, unwitting substitution, undisclosed grade change, impurities etc.

This document does not deal with polyurethane moulding involving the reaction of isocyanates (see HSE Guidance Note EH16[1]), nor with control of exposure to styrene during fibre reinforced laminating.

Health hazards

Plastics are usually processed as pellets, granules or powders which include a number of additives such as fillers, pigments, fire retardants, stabilisers etc, depending upon requirements. The exact composition of any fume produced when the material is heated for processing will therefore vary, but any plastic fume can cause severe irritation to the eyes, nose and lungs. In some cases, the effects can be long-term and irreversible.

Case study

A quantity of acetal was put in a dryer before being injection-moulded. The heat controls on the dryer had not been maintained, and a thermostat stuck ‘on’. The material overheated and began to break down. When an operator opened the dryer door, fume billowed up into his face. He was hospitalised after coughing blood. A sub-3 hour marathon runner, he was subsequently diagnosed asthmatic and unable to run 50 m.

Table 1 gives examples of commonly processed plastics and some of the constituents detected in sampled fume when the plastics were processed, or heated to, above their recommended upper process temperature.

Table 1

Plastic	Examples of detected constituents
PVC	Hydrogen chloride
Fire-retarded ABS	Styrene, phenol, butadiene
Polypropylene	Formaldehyde, acrolein, acetone
Acetals	Formaldehyde
Polyethylene (low density)	Butane, other alkanes, alkenes
Polystyrene	Styrene, aldehydes

Controlling exposure

Fume production is influenced by:

- the material being processed, including recommended temperature ranges and residence/dwell time;
- operating procedures (including purging);
- the reliability of temperature control; and
- machine/screw maintenance.

Checklist

If you can answer ‘Yes’ to all the items in the following checklist, you will be minimising the risk of fume being produced:

Material

- Have we got the Safety Data Sheet (SDS) from the supplier/distributor for this particular formulation**,** including all the information we need on the correct processing temperature, details of degradation products and any additives and their possible effects on fume production?
- Have we checked the supplier has a system for telling us of changes to information in SDSs and that we have a system for reviewing and updating our own records and procedures?
- Have we got accurate information on the residence time in the barrel of this formulation of the polymer at this processing temperature? **Residence time as well as temperature is critical in preventing fume production.** For example, one particular grade of acetal processed at 240°C has a safe residence time of only 7 minutes: it is 20 minutes at 205°C.

Operating procedures

- Do we identify and mark all our virgin and regrind materials clearly so that the wrong material/grade can't be used by mistake?
- Do we give our machine operators all the relevant processing data (temperature, residence time, changes from previous formulation etc)?
- Do we train our operators in the correct ways to:
  - purge? **Purging with purging compound should be done at low speed and pressure.** In some cases, purged material will self-heat on contact with air and should be immersed into cold water as soon as possible;
  - deal with blockages and cleaning? The burning out of nozzles, blocked dies, injectors, material transfer valves, screen filter breaker plates and burning off solidified material should **only** be done under extraction, using pyrolysis units, or by other methods which prevent fume exposure;
  - ensure nozzles seat correctly against sprue bushes to prevent leakage during moulding?
  - handle alarm conditions or moulding problems which cause a halt in processing? This is especially important when processing heat-sensitive materials, eg acetals, PVC etc. Processing acetals can give rise to a 'blow-out', due to rapid degradation in the barrel. Processors should have emergency procedures to deal with this possibility, since formaldehyde may be produced.

See *Safety guidance on the guarding and use of injection moulding machines in the plastics and rubber industries*[2] for more information on purging, dealing with blockages and cleaning.

Temperature control

- Have we equipment and systems for checking that material is being processed at the right temperature?
- Have we a suitable procedure to ensure that the right thermocouples and heater bands are selected and properly fitted? Older machines may not have proportional, proportional-type (PD or PID), or PC-controlled heating. Cycling effects with on/off controllers make heater band failure, and therefore fume problems, more likely.
- Have we inspection procedures to check for visual signs of damage to thermocouples and leads?
- Have we checked that machine alarms and cut-outs are working - including those on ancillary equipment such as dryers? NB A heater band failure can be just as serious as an overheat, as it increases the residence time.
- Have we a procedure to reduce the risk of material degradation when the machine is idling with the barrel full of material at processing temperature, eg by lowering the barrel temperature and/or keeping material moving through the unit? NB Heat-sensitive material such as acetal and PVC will begin to degrade quickly if held at processing temperatures.

Machine/screw maintenance

- Have we assessed the risk posed by screw wear (inadequate flight depth or screw diameter caused by wear can reduce pressure and output, so increasing residence time) and implemented a checking system where necessary?
- Have we procedures to make sure barrels/screws are adequately cleaned after any incident where material has degraded in the barrel? Traces of degraded material can cause rapid degradation of newly-introduced material.
- Have we procedures to make sure machines are kept clean? Spilled materials on the outside of the barrel can heat up and produce fume.

If you were unable to answer 'Yes' to all the questions in the checklist, you may need to improve your existing arrangements. It is important that you:

- set out the procedures to be adopted clearly in writing, to help ensure they are followed exactly as you intended in practice;
- train operators to work to the laid-down procedures, and make sure supervisors regularly check they are being complied with;
- make sure any emergency procedures are clearly explained and practised by all who may need to use them.

If you run machines over ten years old with simple on/off controllers, you should consider refurbishment of the heater system as a way of reducing failures that may cause fume problems.

Depending on the age and sophistication of the machine it may be possible for you to carry out additional checks to reduce the risk of the evolution of harmful amounts of plastic fume.

Ventilation

In all cases a reasonable level of general ventilation should be provided. This should not be less than six air changes per hour, however, eight is recommended for blown film lines to deal with the fume from a burst bubble.

Plant maintenance, following processing parameters and general ventilation will not control fume in all circumstances. Where material manufacturers recommend it, and your own assessment confirms it, local exhaust ventilation (LEV) will be required.

Examples of processes/activities where LEV is likely to be required are:

- recycling of mixed grades of polymer at pelletiser units;
- bag making at sealing heads where film regularly sticks and overheats;
- blown film lines with internal bubble cooling where the fume-laden air needs to be ducted outside;
- burning out blocked dies and nozzles;
- use of older machines where process controls are less reliable.

Relative humidity (RH)

Low levels of RH can cause/contribute to upper respiratory tract irritation. RH levels should be 30% or higher (preferred range 40-60%) to reduce the risk of such problems.

Where there are complaints of upper respiratory tract (eyes, nose and throat) irritation then, regardless of process, a standard investigation should include a measurement of RH.

Maintaining control measures

Once your control measures are in place, you need to maintain them using the following checks and recommended frequencies, so they continue to provide good control all the time. These can be amended and refined in the light of experience.

Daily or at material/grade change

- Check housekeeping - are material storage areas clearly marked, and heater bands/barrel units free of spilled material?
- Do operators have written information giving clear specifications and processing conditions for materials being run?
- Are machine fault alarms (over- and under-temperature, where fitted) working?
- Has the melt temperature been verified?
- Are the local exhaust and general ventilation fans switched on and working?

Monthly

- Are heater bands in good condition? Where not in use, are they being stored in dry, secure areas to prevent water ingress and mechanical damage?

Annually

- Have we checked that the polymer formulations we use have remained similar to those considered in our original risk assessment? If there have been changes, what do we need to amend?
- Have we reviewed operator training and instruction procedures, eg for purging, freeing blockages etc? Do we need to re-issue or revise them?
- Do we need to check for screw flight or barrel wear?
- Have we checked/calibrated temperature controllers?
- Have we had the LEV thoroughly examined (at least 14-monthly) and do we have a record of this?

Emergency procedures

If processing heat-sensitive materials, eg acetals or PVC, have we rehearsed our emergency procedures? These should include evacuation of the area likely to be affected.

Further reading

1 *Isocyanates: Health hazards and precautionary measures* Environmental Hygiene Guidance Note EH16 (Fifth edition) HSE Books 1999 ISBN 0 7176 1701 7

2 *Safety guidance on the guarding and use of injection moulding machines in the plastics and rubber industries* 238/3 BPF 1991 Available from British Plastics Federation, 6 Bath Place, Rivington Street, London EC2A 3JE Tel: 020 7457 5000

3 *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

4 *Fume and temperature control in plastics processing: Practicality of preventing the evolution of plastic process fume through temperature control* CRR231 HSE Books 1999 ISBN 0 7176 2475 7

5 *General ventilation in the workplace: Guidance for employers* HSG202 HSE Books 2000 ISBN 0 7176 1793 9

6 *An introduction to local exhaust ventilation* HSG37 (Second edition) HSE Books 1993 ISBN 0 7176 1001 2

7 *Plastics recycling* Plastics Processing Information Sheet PPIS2 HSE Books 1998

Further information

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

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