Safe collection of wood waste: Prevention of fire and explosion

HSE information sheet

Information Sheet No 32 (Revision 1)

Introduction

This sheet is one of a series produced by HSE in agreement with the Woodworking Machinery Suppliers Association. It gives practical guidance to manufacturers and suppliers of wood waste collection systems on how to reduce fire and explosion risks. More detailed information can be found in the standards and guidance listed in the References section below.

Users may also find this information useful when planning or commissioning a new extraction system or to check the adequacy of an existing one. It also contains advice on how to minimise the risk of fire and explosion when using an existing system.

What are the fire and explosion hazards of wood dust?

Wood dust is considered to be explosive if ignition of part of a cloud of wood dust results in the propagation of flame through the rest of the cloud. The vigour of flame propagation will vary from dust cloud to dust cloud and not all flammable dusts are equally explosive.[1]

The burning of an unconfined wood dust cloud produces a flash fire. However, if the wood dust is contained within a full or partial enclosure, the pressure build-up can produce a destructive explosion. Its severity will depend on the type and concentration of the dust, particle size distribution, moisture content, the size of the source of ignition and the strength of the enclosure.

Generally, the larger the volume of the exploding dust cloud, the more widespread its effects will be. It is important to ensure that wood dust does not escape from collection systems and be allowed to build up within workrooms.

If dust does accumulate, any primary explosion which occurs in a collection unit may stir up dust deposits within the building which houses the plant. Burning particles from the primary explosion can ignite the dust cloud resulting from it, leading to a secondary explosion that is usually more destructive than the first.

The explosibility of wood waste

You should assume that all wood waste is potentially explosive, unless a dust explosion test[1] demonstrates it is not. Wood waste usually has a dust explosion risk where the mean particle size is less than 200 microns, and where as little as 10% of the mixture contains dust less than 80 microns in size. Only weak explosions are likely where the mean particle size exceeds 200 microns.

Wood waste is commonly produced by:

- fine cutting (eg sanding) – which produces a dust of very fine particle size – usually assumed to be explosive;
- sawing and machining hardwoods – often producing wood waste containing considerably more dust than that from softwood – which should be assumed to be explosive;
- the processing of MDF, chipboard and similar boards by machining and sawing – which can be expected to produce waste containing much fine dust – which should be assumed to be explosive;
- machining and sawing softwoods – producing chips, shavings and coarse dust with only a small amount of fine dust – which does not normally create an explosion risk, provided the fine dust is not allowed to separate and accumulate within confined spaces; and
- profiling and moulding components on routers, spindle moulders etc.

When processing a variety of woods and boards, assume that the waste produced is explosive.

Sources of ignition

Common ignition sources include naked flames, faulty or unsuitable electrics and impact sparks.

The sanding or hogging of off-cuts containing metal may produce friction sparks, which can cause sawdust to smoulder and subsequently be fanned into fires or explosions. Use dedicated collection systems for these operations. Consider spark detection and extinguishing devices where there are significant risks.

Hot work involving the careless use of welding or flame-cutting equipment has resulted in many incidents. To prevent this, plant should be isolated and thoroughly cleaned before work starts. Use cold cutting methods whenever possible.

Electrical equipment should be sited away from dusty areas. If this is not practicable, ensure it is adequately protected. The fire and explosion requirements for electrical equipment used to collect wood waste are set out in BS EN 12779:2004.[2]

Collection systems

There are three main types of system for collecting wood waste:

- One or more woodworking machines are exhaust ventilated to a nearby collection unit within the workshop which does not form part of any other exhaust ventilation system.
- Many (perhaps all) of the woodworking machines are ventilated to a collection unit, which can be some distance from the machines and may be inside or outside the workshop (see Figure 1).
- One or more woodworking machines are exhaust ventilated to a nearby collection unit. These units deliver the wood waste into a larger collection unit, usually outside the workshop. This is known as a 'through flow' system.

Ductwork

Make ductwork as short as possible with a minimum number of bends. The design should specify a minimum transport (or conveying) velocity[3] of 20 m/s to minimise dust deposits. Use only conductive materials for ductwork so that any static electricity generated can be discharged to earth.

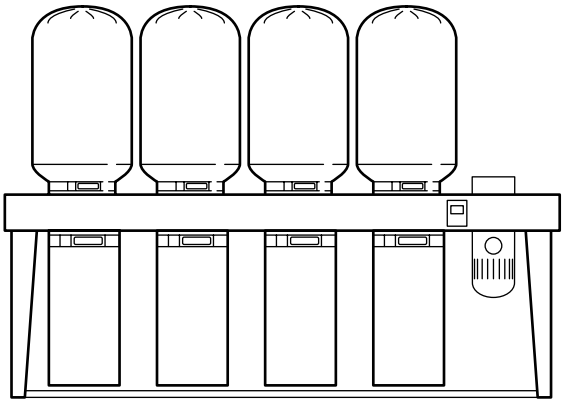

Figure 1 Unenclosed dust collector unit

Ductwork needs to be regularly inspected internally and cleaned to prevent any accumulation of dust. Suitable access points/hatches should be provided for this.

Collection units

There are a number of different kinds of collection unit and the main types are:

- unenclosed fabric filter sock collector;
- unenclosed fabric multi-sock collector (see Figure 1);
- enclosed fabric single-sock collector;
- enclosed fabric multi-sock collector;
- cyclone; and
- bin or hopper.

Precautions for collection units where there is a risk of dust explosion

Collection units should normally be sited outside, away from areas where there may be people. If units have to be indoors, precautions will depend on the size of the collector; the size and construction of the room it is in; the number of people nearby; and how near they are to walkways and combustible materials.

To avoid the risk from secondary explosion or fire, it is essential to enforce good housekeeping practices to prevent the accumulation of wood dust within the building, eg a formal cleaning regime using appropriate vacuums fitted with HEPA-type filters.

Unenclosed sock collectors (<0.5 m^3/s capacity)

These would quickly disintegrate if the contents were ignited, but would not produce high explosion pressures or widespread effects. Fire risks may exist so, if unenclosed, do not position them within 3 m of workers, combustible materials or walkways. Alternatively, provide a suitable baffle or deflector plate or enclosure (see below).

Unenclosed sock collectors (0.5–2.5 m^3/s capacity)

Ignition of wood dust can lead to a jet of flame at head height, but an explosion is not likely. Where such collectors must remain within the workroom, provide one of the following precautions:

- Total enclosure within a strong metal cabinet with either an air outlet large enough in area to act as explosion relief or explosion vents. Outlets or vents should preferably discharge to a safe place outside the workroom or, if inside, discharge at least above head height.

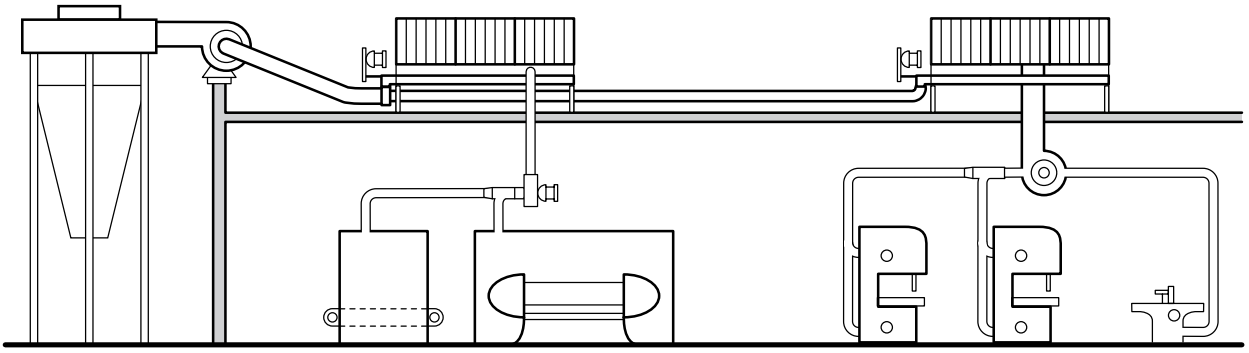

Figure 2 Typical dust extraction system

- A baffle or deflector plate made of non-combustible material to direct flames or burning material to a safe place.
- Ensure the fan can be turned off from a safe place if a fire starts in the filter. A 3 m separation between the filter and regularly occupied locations is likely to be adequate to protect employees.

Unenclosed sock collectors (>2.5 m³/s capacity)

Site these outside or enclose them in a strong cabinet fitted with explosion vents that discharge to a safe place. BS EN 14491:2006[4] specifies the basic design requirements for selecting a dust explosion venting system.

Enclosed sock or fabric filter collectors (<0.5 m³/s capacity)

The top of the enclosure may be open as long as it discharges to a safe place, eg above head height.

Enclosed sock or fabric filter collectors (0.5–2.5 m³/s)

Total enclosure within a strong metal cabinet with either an air outlet large enough in area to act as explosion relief or explosion vents. Outlets or vents should preferably discharge to a safe place outside the workroom or, if inside, discharge at least above head height.

Enclosed sock or fabric filter collectors (>2.5 m³/s)

The enclosure should be strong with explosion vents that discharge to a safe place. BS EN 14491:2006 specifies the basic design requirements for selecting a dust explosion venting system.

Cyclones

Well-made cyclones of less than 0.5 m³/s volume (rare in woodworking) do not usually require explosion relief panels. Larger low-efficiency cyclones usually have large enough air outlets to act as an explosion vent, but the need for additional explosion venting should be assessed. Larger high-efficiency cyclones do not usually have large enough air outlets to act as effective explosion vents and so additional venting will be necessary. Where cyclone air outlets discharge to an after filter, both the cyclone and the after filter will need explosion-relief panels. Safety issues about venting of explosions are covered in HSG103.[1] Where explosion venting is required, BS EN 14491:2006 specifies the basic requirements.

Bins or hoppers

Where used to store explosible wood waste, these will require explosion relief appropriate to their volume. They should preferably be outdoors but, if indoors, additional explosion relief may be required on the building itself. There should also be a safe system of work for emptying bins and hoppers.

Interconnected plant

Take precautions to prevent an explosion spreading between interconnected units of plant, such as collectors, cyclones, filters and incinerators.[1]

Collectors should discharge their collected wood waste through an explosion choke, eg a rotary valve, or directly into strong metal containers clamped firmly to the discharge outlets.

Where rotary valves are intended to act as explosion chokes, they must be certified as explosion protection devices under the Equipment and Protective Systems Intended for Use in Explosive Atmospheres Regulations 1996 (EPS Regulations).[5] They need metal

blades which are rigid enough not to deform under a pressure wave, and which have as small a clearance as practicable from the casing.

Screw conveyors may be used to choke a dust explosion by omitting one turn of the flight. This is to ensure a plug of material remains in the screw conveyor to prevent propagation beyond this point.[1,6] On an inclined conveyor the screw will not empty itself below the missing flight even when the supply of feed to the lower end is stopped. On a horizontal conveyor, an adjustable baffle plate is needed to complete the seal of dust with the upper side of the casing.

Where the wood waste is delivered out of the collector to downstream plant, eg feed bins for an incinerator, then it is necessary to stop at least every rotary valve discharge on the collector if there is a fire or explosion. This can be done by arranging trip switches activated by explosion-relief panels on the collector to cut the power, or by fitting a pressure switch in the hopper.

Sizing of explosion relief

The simplest and most common method of protecting process plant against the consequences of a dust explosion inside it is to provide some deliberate weakness in the structure in the form of explosion-relief vents. Suitably sized and sited vents will ensure any explosion within the plant will be vented safely.

A traditional method of sizing explosion relief is the vent ratio rule. This is suitable for users to check that existing plant has enough explosion relief. For plant up to 30 m^3, a vent area of 1 m^2/6 m^3 of volume is prescribed. For plant of over 300 m^3 a vent area of 1 m^2/25 m^3 is recommended, and for plant of intermediate volume, the vent area is adjusted linearly with volume. Seek specialist advice if you are unsure.

More recent research has provided better calculation methods. The nomograph method is the most useful approach and the one that should be used by designers.[1,6]

Design of explosion vents

Vents normally take the form of bursting panels or explosion doors. Some types of panel are designed to tear at a pressure, others may bend or pop out from a rubber seal, or be held in place by magnets. To open rapidly, vents should be lightweight, normally less than 10 kg/m^2.

Newly supplied vent covers should conform to the EPS Regulations. The requirements include testing of the covers by a recognised test house (a notified body under the Supply of Machinery (Safety) Regulations 2008) and CE marking.[7]

Panels which could become dangerous missiles in an explosion should be attached by a restraint, eg a strong chain or cable. The chain needs to be long enough to allow the panel to open fully.

Panels are generally non-load bearing and classed as a fragile material, so you must have appropriate precautions in place to control the risk of a fall if access is foreseeable.

Ducting of explosion vents or panels to the open air

Vent ducts are used to direct a vented explosion to a safe area, usually from plant sited in a building to the open air. Because vent ducts impede the venting process, the reduced explosion pressure in the protected equipment is generally increased. The design of the vent duct should be in accordance with BS EN 14491:2006, which also includes details on vent design and strength of the enclosure.

If plant cannot relieve to a safe place in the open air, then blast deflector plates may provide limited protection. Where explosion vents cannot be ducted to the open air, the collector should be re-sited. If this is not possible, they should not discharge into occupied workrooms or areas containing combustible material. Proprietary flameless venting devices, which quench flames and catch burning dust, are also available.

Fire fighting

Consider installing a dry sprinkler system and a C-coupling for attachment to a fire-brigade hose (on new plant). Make sure access doors on silos are big enough to allow access for fire fighting. Use gently applied water (eg a spray or mist), not jets to extinguish fire, to minimise the disturbance of burning wood waste.

Additional precautions by users

Users should take the following practical precautions to minimise fire and explosion risks:

- Ensure there is a preventive maintenance regime for the entire collection system. Details of the requirements for maintenance and thorough examination and testing can be found at www.hse.gov.uk/lev/index.htm and in HSG258.[3]

- Leave the fan running for some time after the machines have been turned off to ensure the ducts are empty when the air flow stops, and minimise dust fall-out in the ducting.
- Keep the system dust-tight.
- Replace seals, gaskets and covers as necessary.
- Empty containers associated with filters regularly.
- Take care to prevent metal objects entering the collection system.
- Smouldering fires often precede explosions – if a fire is suspected, stop the air flow through the collection system before investigating the problem.

Consider also the following general risks:

- Safe access for collecting/replacing filters etc.
- Confined spaces.
- Maintenance issues such as safe isolation and blockage clearance.

Legal requirements

The key legal requirements covering the supply and use of wood waste collection systems are the Supply of Machinery (Safety) Regulations 2008; section 6 of the Health and Safety at Work etc Act 1974; the Dangerous Substances and Explosive Atmospheres Regulations 2002;[8] the Management of Health and Safety at Work Regulations 1999; and the Provision and Use of Work Equipment Regulations 1998.

References and further reading

1 *Safe handling of combustible dusts: Precautions against explosions* HSG103 (Second edition) HSE Books 2003 ISBN 978 0 7176 2726 4

2 BS EN 12779:2004 + A1:2009 *Safety of woodworking machines. Chip and dust extraction systems with fixed installation. Safety related performance and safety requirements* British Standards Institution

3 *Controlling airborne contaminants at work: A guide to local exhaust ventilation (LEV)* HSG258 HSE Books 2008 ISBN 978 0 7176 6298 2

4 BS EN 14491:2006 *Dust explosion venting protective systems* British Standards Institution

5 *The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996* SI 1996/192 TSO 1996 ISBN 978 0 11 053999 7

6 *Dust explosion prevention and protection: A practical guide* Institution of Chemical Engineers 2002 ISBN 978 0 85295 410 2

7 *The Supply of Machinery (Safety) Regulations 2008* SI 2008/1597 TSO 2008 www.opsi.gov.uk/si/si2008/pdf/uksi_20081597_en.pdf

8 *Dangerous substances and explosive atmospheres. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance* L138 HSE Books 2003 ISBN 978 0 7176 2203 0

9 *Dust explosions from unenclosed sock filters* CRR176 HSE Books 1998 ISBN 978 0 7176 1577 3

Further information

Further information on health and safety for woodworking can be found on HSE's woodworking website: www.hse.gov.uk/woodworking/

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.

British Standards can be obtained in PDF or hard copy formats from BSI: http://shop.bsigroup.com or by contacting BSI Customer Services for hard copies only Tel: 020 8996 9001 email: cservices@bsigroup.com.

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

This document is available at www.hse.gov.uk/pubns/wis32.pdf