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Risk Control

Fire safety in the manufacture of biodiesel fuel



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➤ SCOPE

These recommendations concern the manufacture of biodiesel fuel from animal fats and vegetable oils. Although biodiesel fuel is not readily available to the public, many small-scale continuous and batch manufacturing processes are now in operation. The volumes of fuel being produced, the scale of the equipment and the associated facilities are rapidly expanding. The process has come of age, the initial amateur pilot plants having been superseded by commercially available processing equipment producing viable quantities of a sustainable fuel.

Issues relating to the storage and use of biodiesel fuel are not addressed in these recommendations. Although biodiesel fuel itself is not defined as flammable or highly flammable, it is recommended that the precautions documented in recommendations for the storage and use of highly flammable and flammable liquids (refs. 1, 2 and 3) are observed. The manufacture of the raw materials is outside the scope of these recommendations.

These recommendations describe a simple biodiesel manufacturing process; there are several alternative approaches which involve the use of other hazardous materials. The batch production process described here is being developed for continuous manufacture of the fuel.

➤ SYNOPSIS

These recommendations apply to a batch manufacturing process for biodiesel fuel and the fire hazards associated with the process and the materials involved. Guidance is presented with a view to minimising the fire hazards and promoting suitable fire prevention and fire protection techniques.

➤ DEFINITIONS

Biodiesel

A fuel comprised of mono-alkyl esters of long-chain fatty acids derived from vegetable oils or animal fats.

Catalyst

A chemical, the presence of which is necessary for a reaction to take place, but which remains unaffected during the process.

Classification of hazardous areas

(BS EN 60079-10: 2003) (ref. 4)

(This classification refers to areas in which open processes are carried out; areas in which closed processes are undertaken should be subject to a risk assessment.)

Zone 0: An area in which an explosive gas atmosphere is present continuously or for long periods.

Zone 1: An area in which an explosive gas atmosphere is likely to occur in normal operation.

Zone 2: An area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only.

Ester

An organic compound formed by replacing the hydrogen atom of an acid molecule with a simple organic group.

Flashpoint

(BS EN 60079-10: 2003) (ref. 4)

The lowest liquid temperature at which, under certain standardised conditions, a liquid gives off vapours in a quantity such as to be capable of forming an ignitable vapour/air mixture.

➤ INTRODUCTION

Biodiesel fuel is the common name for a clean burning fuel (in chemical terms a mixture of methyl esters) produced from renewable biomass resources, vegetable oil or animal fats. The fuel can also be produced from waste cooking oil, such as that removed from deep fat fryers.

Although it contains no petroleum, biodiesel fuel can be blended with hydrocarbon-based diesel fuel to create a biodiesel blend. The neat fuel, or a blend, can be used in compression-ignition (diesel) engines to power vehicles, generators and the like. Blends containing a proportion of biodiesel fuel can be used in conventional diesel engines without modification, but blends of biodiesel and hydrocarbon diesel fuel have been reported to degrade rubber gaskets and hoses in older vehicles. Biodiesel is a better solvent than hydrocarbon diesel and has been known to break down deposits of residue in the fuel lines of vehicles which usually run on conventional fuel.

Biodiesel fuel is relatively simple to produce, but its manufacture should only be carried out in controlled conditions by competent people. The fuel is biodegradable, non-toxic, and burns to produce less carbon monoxide, carbon dioxide, sulphur, aromatic hydrocarbons and particulates than conventional hydrocarbon-based diesel fuel. This is offset slightly by an increased production of nitrogen oxides (NO_x), but these can be reduced by fitting a catalytic converter. The fuel is environmentally friendly because it is made from renewable resources. It is reported to be less toxic than table salt and to biodegrade as quickly as sugar. Biodiesel fuel is distinctly different from raw vegetable oil but, in common with this product, its viscosity increases in cold weather.

Unblended biodiesel fuel has a flashpoint in excess of 130°C and so the fuel is not considered to be a highly flammable or flammable liquid (ref. 1). The end product, biodiesel fuel, therefore, does not fall within the definition of a 'dangerous substance' as referred to in the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (ref. 5).

Although biodiesel is not itself a highly flammable or flammable liquid, the most commonly adopted manufacturing process involves the use of methanol (methyl alcohol) as one of the reactants. This has a flashpoint of 10°C and thus is defined as a highly flammable liquid. A suitable and sufficient assessment including consideration of the explosive hazards associated with this chemical should therefore be carried out in order to comply with DSEAR.

The other principal product of the reaction, glycerol (glycerine), has a flashpoint of 160°C and, like biodiesel, is not a highly flammable or flammable liquid.

A suitable and sufficient fire risk assessment of the hazards likely to arise as a result of the manufacture, storage or use of biodiesel fuel should be conducted in compliance with the Regulatory Reform (Fire Safety) Order 2005 (ref. 6) or the equivalent legislation in Scotland and Northern Ireland (refs. 7-9).

Any actions identified as being necessary to eliminate, reduce or control hazards identified in the assessment, such as problems that may arise from poor mixing or incorrect quantities of raw materials, should be addressed and recorded.

There are several processes that may be used to produce biodiesel fuel, and only the most commonly adopted method is described here. Other processes may use different reactants and thus will need to be carefully assessed to identify the fire hazards associated with them.

Proprietary small-scale manufacturing equipment is readily available, although custom-built, converted or home-made equipment is used in some operations.

The manufacturing process involves the storage, handling and use of the animal or vegetable oils or fats, an alcohol such as methanol (methyl alcohol), an alkali such as sodium hydroxide or potassium hydroxide (or an acid), together with the biodiesel and glycerol products.

The process

The manufacturing process essentially involves the reaction of a feedstock of vegetable oil or animal fat with an alcohol (methanol is commonly used for ease of recycling and economic reasons but ethanol, isopropanol or butyl alcohols may be employed) in the presence of an acid or alkali catalyst, such as sodium hydroxide, to produce a complex mixture of methyl esters. (Some methods vary the process by using sodium methoxide rather than the alkali catalyst.) This fuel is then cleaned and blended with hydrocarbon fuel or used directly in diesel engines. Also produced as a by-product of the reaction is glycerol, a non-toxic material that is widely used in the cosmetics and pharmaceuticals industries. This may be used locally – as a polish, for example – or resold.

The manufacture may be carried out in a batch or continuous process and there are several methods; the following, however, are the essential steps in the process. Further details of the process are set out later in this document.

Preparation of the feedstock

The feedstock may be quite impure, having been derived from pressed crops or waste oil from other processes. It is essential that any suspended particles are removed by filtration; the application of heat or pressure may be necessary to produce an efficient rate of flow during this process. Following the filtration, washing and drying of the oil may be necessary, the latter accomplished using a solid adsorbent.

Figure 1 shows an example of a biodiesel process. Other processes may use different feedstocks and produce other by-products.

Preparation of the reactants

The catalyst – normally sodium hydroxide, potassium hydroxide or sodium methoxide – is dissolved in methanol; the chemicals are agitated or stirred to ensure adequate mixing. There is a hazard in that this process could cause a build-up of static electricity and thus the metal vessels used, together with other extraneous metal items involved in the preparation should be bonded and earthed to prevent this. This is a hazardous process for which suitable personal protective equipment should be worn, including breathing apparatus, goggles or a visor, and anti-static footwear. An excess of methyl alcohol (methanol) is normally added at this stage of the process to ensure the total conversion of the fat or oil to its esters.

The area where this process is undertaken should be ventilated. Where mechanical ventilation is used, only equipment that is suitable for the hazard zone in which it is required to operate should be used.

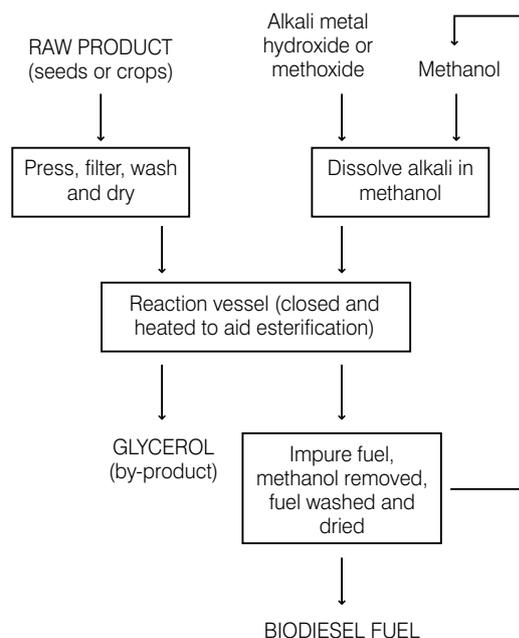
The reaction

The alcohol and catalyst mixture is introduced into the reaction vessel, which takes the form of a large closed container. This container should be clean and made from a suitable material so as to resist attack by the acids or alkalis used in the process. The feedstock oil is added and the vessel is closed to the atmosphere to prevent loss of the alcohol by evaporation. The mixture may then be heated to accelerate the reaction, which typically takes between one and eight hours. Although in some processes the reaction is not undertaken under pressure, in other plants, pressures of up to 80bar may be encountered.

Glycerol separation

Following completion of the reaction, the glycerol by-product, which is more dense than the methyl esters (biodiesel fuel) that have been produced, will settle at the bottom of the reaction vessel from where it can be drawn off. In some large facilities, a centrifuge is used to separate the phases more quickly.

Figure 1: Example of a simple biodiesel fuel manufacturing process



Removal of excess alcohol

The excess methanol is recycled and removed from the biodiesel and glycerol phases by evaporation or distillation (sometimes under reduced pressure). It is then reused. In some manufacturing methods, the alcohol is removed from the mixed biodiesel and glycerol before separation. The recovery process may produce volumes of flammable vapour and thus the process must be carefully controlled by effective condensers.

Alternatively, the excess alcohol may be washed out of the biodiesel using water, with subsequent distillation of the aqueous phase to recover the methanol.

Purification

Once separated from the glycerol, the biodiesel may be purified by washing with warm water to remove residual catalyst and glycerol. In this case, the fuel will need to be dried using an

inert drying agent, followed by separation of the solid and liquid phases before storage. An alternative, and more environmentally friendly, method involves 'dry washing' using magnesium silicate ('Magnesol').

Large-scale production

Although the above paragraphs outline the batch process, the principles of large-scale continuous production mirror these stages. Large-scale production is more prevalent in the USA, using commercially grown rape seed and similar crops.

➤ **RECOMMENDATIONS**

1. Legislation

- 1.1 The fire risk assessment for the manufacture of biodiesel fuel should be carried out in compliance with the Regulatory Reform (Fire Safety) Order 2005 (ref. 6) or the equivalent legislation in Scotland and Northern Ireland (refs. 7-8). The assessment should be recorded where five or more people are working in the premises.
- 1.2 A suitable and sufficient assessment should also be undertaken in compliance with DSEAR (ref. 5). The significant findings of the assessment must be recorded where five or more people work in the premises.
- 1.3 Irrespective of how many people work in the premises, where a highly flammable liquid such as methanol is present, an assessment of the production and storage areas should be carried out and appropriate 'zones' should be assigned in accordance with BS EN 60079-10 (ref. 4).
- 1.4 When the hazardous area classification study has been completed, a diagram should be produced indicating the hazard zones; this diagram should be brought to the attention of all staff. The survey and production of the diagram should be completed before the plant is tested and commissioned (refs. 10-13).
- 1.5 Although glycerol, oil, fats and pure biodiesel fuel have flashpoints above 55°C and are therefore not normally classed as dangerous substances under DSEAR, in some circumstances conditions might occur which result in these substances causing a hazard. For example, operation at high temperature or if pressure builds up in the reaction vessel a release may form an oil mist. Such circumstances should therefore be considered when the assessment in compliance with DSEAR is undertaken.
- 1.6 If 1 tonne or more of biodiesel is produced annually, manufacturers should register with the European Chemicals Agency in compliance with the European Registration Evaluation Authorisation and Restriction of Chemicals (REACH) legislation (ref. 14). Appropriate data on the product must also be supplied to this agency.

2. General

- 2.1 The manufacturing of biodiesel fuel is a potentially hazardous process that should only be carried out in controlled conditions by people with suitable training and experience. The process should be planned, managed and carried out effectively.
- 2.2 The manufacture of biodiesel should be undertaken using proprietary, rather than home-made, equipment and this should be installed, used and maintained in accordance

with the manufacturer's instructions. The equipment should be serviced and maintained by the manufacturer or installer and suitable records should be kept.

- 2.3 Where manufacture cannot be undertaken in a detached building, the process should be undertaken in a compartment with at least one external wall. This compartment should be separated from other manufacturing and storage areas by a continuous construction affording at least 120-minutes' fire resistance (ref. 15). Doors from the biodiesel production area should open directly to the outside.
- 2.4 Manufacture should be undertaken at ground floor level, away from drains and openings to lower areas of the premises in order to prevent spillages entering water courses or drains (ref. 16). In the case of large-scale production, serious consideration should be given to bunding the production area to retain any spillages (which should be made safe as soon as possible).
- 2.5 Only the minimum quantities of feedstock oil and reactants should be stored within the compartment housing the reaction vessel(s). Additional stocks of the feedstock, reactants and products should be stored elsewhere in a suitable fire-resisting enclosure.
- 2.6 Even if a closed reaction vessel is not intended to operate under pressure, it should be fitted with a pressure relief valve designed to vent any flammable vapours released to a safe area outside the premises. The valve should operate if excess pressure is generated and should be designed to allow the operation of the valve to be monitored by a remote alarm. (If the reaction vessel is pressurised to a significant extent then the requirements of the Pressure Systems Safety Regulations (ref. 17) may apply.)

Where closed vessels are to be employed, specialist advice should be sought regarding the design of the pressure relief system. This is particularly important if the vessel is being used to form the methoxide, as the risk of exothermic runaway will need to be evaluated. Even if thermal runaway is not envisaged during the process, a simple breather vent would not normally be considered suitable for emergency pressure relief purposes.
- 2.7 To prevent the evaporation of methanol from an open reaction vessel, a suitable reflux condenser should be fitted. Consideration needs to be given to any vent streams so that they are vented to a safe area away from the production area in order to minimise the possibility of a flashback.
- 2.8 The reaction vessel should be heated indirectly using hot water or a heat exchange method. Open flames must not be used. The application of heat could lead to the discharge of flammable vapours where these would not normally occur at ambient temperature, and thus produce a hazardous atmosphere. This should be borne in mind when identifying hazard zones for the process in accordance with BS EN 60079-10 and DSEAR (refs. 4 and 5).

In a similar fashion, any heating required in the recycling process should be applied indirectly.
- 2.9 All metal reaction vessels, metal receivers and extraneous metal items used as parts, or supports, for the process

should be bonded and earthed to prevent the build-up of static electricity. 2.10 Electrical equipment and wiring should be certified as suitable for use within the zone in which the flammable liquid is being stored or processed (ref. 4), as determined by a risk assessment. They should also comply with the provisions of the Electricity at Work Regulations 1989 (ref. 18). All electrical installations and maintenance thereof should comply with BS EN 60079-14 and the guidance set out in the Recommendations for the selection of electrical and non-electrical equipment for use in atmospheres containing flammable or explosive gases or vapours (refs. 19 and 20).

- 2.11 Check valves should be fitted as appropriate to prevent backflow of reactants and products.
- 2.12 The manufacturing and storage areas should be heated by ducted warm air or by hot water radiators. All possibility of flammable vapours coming into contact with an ignition source must be avoided.
- 2.13 High standards of housekeeping should be maintained to prevent the accumulation of combustible materials in the vicinity of the biodiesel plant.
- 2.14 As biodiesel degrades over a period of time, the production and storage of excessive stocks of the fuel should be avoided.
- 2.15 Staff using the equipment should be trained in the use of the facility and the fire protection measures provided.

3. Hazardous materials

- 3.1 All products, raw materials and biodiesel fuel should be stored in containers in a bund or other form of secondary containment to safeguard against spillage. The bund or containment should be constructed of non-permeable materials, and should have the capacity of 110% of the largest container to be stored within it, or 25% of the aggregate storage capacity of the containers, whichever is greater.
- 3.2 The reaction vessel should be protected by a form of secondary containment, or the area in which it is situated should incorporate raised sills at the threshold.
- 3.3 Care must be taken to ensure that biodiesel fuel, flammable liquids (such as methanol used in its production), acids, alkalis and any glycerol by-product do not enter the drains. If oil and chemicals from the site enter the ground or watercourses, 'the polluter pays' principle will apply and those responsible can be required to pay for the decontamination.
- 3.4 Care must be taken as in some circumstances methanol may not be completely removed from the finished product, or may be present as a result of degradation of the fuel. Biodiesel fuel contaminated with significant amounts of methanol may have a flashpoint sufficiently low as to be classed as dangerous under DSEAR (ref. 5).
- 3.5 Alkali metal hydroxides and methoxides that may be used in the reactions are hazardous materials; in particular:
- mixing sodium or potassium hydroxide with methanol is highly exothermic;
 - sodium methoxide is a flammable solid and thus poses a dust explosion hazard;

- sodium methoxide reacts violently with water;
- methanol solutions of methoxides are highly flammable liquids (but are less likely to react violently with cold water); and
- a methanol solution may evaporate to leave a deposit of solid methoxide.

3.6 A suitable supply of non-combustible absorbent materials should be available in case of spillage. Containers should be available to allow used absorbent materials to be disposed of safely; all spillages should be mopped up without delay.

3.7 As biodiesel fuel contains some unsaturated derivatives of vegetable oils, there is a danger of self-heating if the fuel comes into contact with an absorbent material, such as rags or lagging.

Any lagging or similar absorbent material that becomes contaminated with biodiesel fuel or vegetable oil should be removed and placed outside the building in a non-combustible container fitted with a non-combustible lid to await disposal (ref. 21). Removed lagging may need to be replaced.

3.8 Methanol is a toxic substance which has a flashpoint of 10°C and thus should be stored, handled and used observing the safety measures that should be taken for highly flammable liquids (refs. 1, 2 and 3).

3.9 Care should be taken when handling waste products from the process, as residual methanol and un-reacted methoxide or hydroxides could be present. Chemical waste should be stored and disposed of in accordance with the requirements of the Environmental Protection Act 1990 (ref. 22). It should be retained in suitable containers to await removal from the site by a competent waste carrier.

3.10 Adequate ventilation should be provided from the storage and production areas direct to the open air by natural or suitably protected mechanical means. This is to prevent the concentration of flammable vapours accumulating to within their explosive limits.

3.11 To avoid a potentially hazardous reaction, any glycerol produced should not be stored in the same compartment as an oxidising agent (ref. 23).

3.12 Smoking

3.12.1 Smoking should be prohibited in all areas outside the premises where methanol or other highly flammable or flammable liquids are used or stored. Appropriate notices should be prominently displayed.

3.12.2 Where a smoking shelter is provided it must be:

- outside the building;
- subject to a specific fire risk assessment;
- constructed of non-combustible materials;
- where practicable, sited at least 10m away from any building or structure, including gas cylinder and flammable liquid stores;
- provided with suitable metal ashtrays and a separate metal waste bin with a fitted metal lid; and
- provided with a suitable fire extinguisher.

- 3.12.3 The immediate area around the shelter and the shelter itself should be kept clear of combustible materials including windblown debris and vegetation.
- 3.12.4 Raised, slatted floors or decking should not be used and concealed or semi-open spaces should be sealed to ensure combustible debris cannot accumulate beneath the shelter.
- 3.12.5 The use of combustible curtains, canopies and drapes to protect smokers from the elements must be avoided.
- 3.12.6 In no circumstances should the shelter be sited near:
- windows;
 - ventilation intakes or extracts;
 - entrances and exits from the premises;
 - hazardous materials;
 - waste storage containers (such as skips or bins); or
 - beneath a canopy or low slung eaves.
- 3.12.7 Areas where smoking is allowed but no shelter is provided must be free of combustible materials and be equipped with firefighting equipment, metal ashtrays and a separate metal waste bin with a fitted metal lid.
- 3.12.8 A 'no smoking' policy must be established in outside areas where fire hazards exist. Such areas may include refuse and storage areas containing combustible materials, flammable liquids (including refuelling supplies), gas cylinders, foam plastics, fibreboard and timber. 'NO SMOKING' notices must be displayed prominently in these areas.

4. Fire protection

- 4.1 Biodiesel fuel, vegetable oils, animal fats and glycerol are not miscible with water and so fires involving these substances should be fought with foam, dry powder or carbon dioxide extinguishers. These should be approved and certified by an independent, third-party certification body and be provided in accordance with BS 5306-8 (ref. 24).
- 4.2 Methanol burns with very pale blue flames which cannot easily be seen. Fires involving methanol may be fought using the same extinguishers as indicated in paragraph 4.1, but as methanol is miscible with water, this agent may also be used to extinguish a methanol fire by diluting the residual alcohol and thus reducing the volume of flammable vapours produced.
- 4.3 Drums and tanks of methanol and biodiesel fuel should be protected from direct sunlight. Containers exposed to heat should be cooled with jets of water.
- 4.4 Automatic sprinklers installed in accordance with the **LPC Rules for automatic sprinkler installations incorporating BS EN 12845** (ref. 25) should be considered for protecting the production and storage building(s). Such systems should be serviced and maintained in accordance with this standard by engineers accredited by a third-party certification body.
- 4.5 Automatic fire detection should be installed in accordance with BS 5839-1 (ref. 26). As methanol flames produce little smoke, appropriate heat detectors should be installed. Consideration may also be given to the use of ultra-violet detectors. A suitable system should be installed and maintained by engineers accredited by a third-party certification body.

Fire-related properties of hazardous materials involved in the manufacturing process

Biodiesel fuel The properties of the fuel may vary depending on the composition, but typically may have a flashpoint of 38°C and an autoignition temperature in the region of 257°C. Fires involving biodiesel fuel should be fought with foam or dry powder extinguishers.

Methanol is highly flammable and a cumulative poison. It has a flashpoint (closed cup method) of 10°C and an autoignition temperature of 455°C. It forms an explosive mixture with air in concentrations between 6.7% and 36% by volume. Methanol has a boiling point of 65°C and although it has a specific gravity of 0.79, it is miscible with water, acetone, ether, chloroform and ethyl alcohol. Methanol fires may therefore be fought with water extinguishers.

Glycerol is a colourless, viscous liquid. Also known as glycerine, it reacts violently with some oxidising agents and thus should not be allowed to come into contact with these materials. Glycerol has a flashpoint of 160°C and an autoignition temperature of 370°C. Fires involving glycerol should be fought with dry powder, carbon dioxide or alcohol-resistant foam.

Sodium hydroxide and potassium hydroxide are not combustible but are extremely corrosive, can cause burning to unprotected skin and are particularly damaging to the eyes. In the case of eye contact, immediate and prolonged irrigation with water should be undertaken and medical help sought urgently.

For safety, when dissolving an alkali it should always be added to the methanol and/or water and not vice versa.

5 Checklist

5.1 Legislation (Section 1)	Yes	No	N/A	Action required	Due date	Sign on completion
5.1.1 Has a suitable and sufficient risk assessment been undertaken in compliance with the Regulatory Reform (Fire Safety) Order 2005 (or the equivalent legislation in Scotland and Northern Ireland) (1.1)?						
5.1.2 Has an assessment been undertaken in compliance with the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 (1.2)?						
5.1.3 Has an assessment of the production and storage areas been carried out and appropriate 'zones' assigned in accordance with BS EN 60079-10? (1.3)						
5.1.4 Following the hazardous area classification study, has a diagram been produced indicating the hazard zones? (1.4)						
5.1.5 Have the effects of operating at high temperature and/or pressure been considered when the undertaking the assessment in compliance with DSEAR? (1.5)						
5.1.6 If 1 tonne or more of biodiesel is to be produced annually, has registration been made under the European REACH legislation and has appropriate data been provided to the European Chemicals Agency? (1.6)						
5.2 General (Section 2)						
5.2.1 Is the process being undertaken by people with suitable training and experience? (2.1)						
5.2.2 Is the equipment used proprietary rather than home-made, and is it installed, used and maintained in accordance with the manufacturer's instructions with suitable records being kept? (2.2)						
5.2.3 If the manufacture cannot be undertaken in a detached building, is the process undertaken in a compartment with at least one external wall and separated from other manufacture and storage areas by construction affording at least 120-minutes' fire resistance? (2.3)						
5.2.4 Is manufacture undertaken at ground floor level, away from drains and openings to lower areas of the premises in order to prevent spillages entering watercourses or drains? (2.4)						
5.2.5 Are only the minimum quantities of feedstock oil and reactants stored within the compartment housing the reaction vessel(s)? (2.5)						
5.2.6 Even if a closed reaction vessel is not intended to operate under pressure, has it been fitted with a pressure relief valve designed to vent any flammable vapours released to a safe area outside the premises? (2.6)						
5.2.7 To prevent the evaporation of methanol from an open reaction vessel, has a suitable reflux condenser been fitted and consideration been given to venting vapours to a safe area and minimising the possibility of a flashback? (2.7)						
5.2.8 Is the reaction vessel heated indirectly using hot water or a heat exchange method? (2.8)						
5.2.9 Are all metal reaction vessels, metal receivers and extraneous metal items used as parts or supports for the process bonded and earthed to prevent the build-up of static electricity? (2.9)						
5.2.10 Is electrical equipment and wiring certified as suitable for use within the zone in which the flammable liquid is being stored or processed, as determined by a risk assessment? (2.10)						

	Yes	No	N/A	Action required	Due date	Sign on completion
5.2.11 Are check valves fitted as appropriate to prevent backflow of reactants and products? (2.11)						
5.2.12 Are the manufacturing and storage areas heated by ducted warm air or by hot water radiators with all possibility of flammable vapours coming into contact with an ignition source being avoided? (2.12)						
5.2.13 Are high standards of housekeeping maintained to prevent the accumulation of combustible materials in the vicinity of the biodiesel plant? (2.13)						
5.2.14 As biodiesel degrades over time, are the production and storage of excessive stocks of fuel avoided? (2.14)						
5.2.15 Are staff that use the equipment trained in the use of the facility and the fire protection measures provided? (2.15)						
5.3 Hazardous materials (Section 3)						
5.3.1 Are the feedstock oil and the biodiesel product stored in containers in a bund or other form of secondary containment to safeguard against spillage? (3.1)						
5.3.2 Is the reaction vessel also protected by a form of secondary containment? (3.2)						
5.3.3 Is care taken to ensure that biodiesel fuel, flammable liquids, acids, alkalis and any glycerol by-products do not enter the drains? (3.3)						
5.3.4 Is care taken to ensure that methanol is completely removed from the finished product to avoid the flashpoint of the fuel being sufficiently low as to be classed as dangerous under DSEAR? (3.4)						
5.3.5 Are alkali metal hydroxides and methoxides that may be used in the reactions recognised as hazardous materials? (3.5)						
5.3.6 Is a suitable supply of non-combustible absorbent materials available in case of spillage, and are containers available to allow used absorbent materials to be disposed of safely? (3.6)						
5.3.7 Is any lagging or similar absorbent material that becomes contaminated with biodiesel fuel or vegetable oil removed and placed outside the building in a non-combustible container fitted with a non-combustible lid to await disposal? (3.7)						
5.3.8 Is methanol stored, handled and used observing the safety measures that should be taken for highly flammable liquids? (3.8)						
5.3.9 Is care taken, when handling waste products from the process, to ensure that they are free of residual methanol and un-reacted methoxide or hydroxides? (3.9)						
5.3.10 Is adequate ventilation provided from the storage and production areas direct to the open air by natural or suitably protected mechanical means to prevent the concentration of flammable vapours accumulating to within their explosive limits? (3.10)						

	Yes	No	N/A	Action required	Due date	Sign on completion
5.3.11 Is any glycerol produced stored in a separate compartment from oxidising agents? (3.11)						
5.3.12 Is smoking prohibited in all areas outside the premises where methanol and any other flammable and highly flammable liquids are used or stored? (3.13)						
5.4 Fire protection (Section 4)						
5.4.1 Are suitable fire extinguishers provided in accordance with BS 5306-8? (4.1)						
5.4.2 Is water also available to extinguish a methanol fire by diluting the residual alcohol and thus reducing the volume of flammable vapours produced? (4.2)						
5.4.3 Are drums and tanks of methanol and biodiesel fuel protected from direct sunlight? (4.3)						
5.4.4 Have automatic sprinklers installed in accordance with the LPC Rules for automatic sprinkler installations been considered for protecting the production and storage buildings? (4.4)						
5.4.5 Has appropriate automatic fire detection been installed in accordance with BS 5839-1? (4.5)						

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