GUIDELINES FOR THE MANAGEMENT OF WASTE ACETYLENE CYLINDERS

Doc 05/21

Revision of Doc 05/20

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Prepared by WG-5 Environment

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Amendments to 05/20

Section	Change
	Replace term ‘monolithic / porous mass’ with ‘porous material’

NOTE Technical changes from the previous edition are underlined

1 Introduction

This publication was originally produced in 1993 and has been regularly updated with developments in environmental policy and practice as well as advances in methods of destruction of asbestos. The main principles remain unchanged; a commitment to the identification of best industry practice and guidance to EIGA members on its implementation.

2 Scope and purpose

2.1 Scope

This publication sets out the standards for the safe treatment or disposal of acetylene cylinders and reflects the priority that EIGA gives to the protection of people and the environment.

The publication determines the standards to be achieved and describes methods by which these can be achieved. Methods should only be adopted where an equivalence of safety can be demonstrated.

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicate that the procedure is optional.

3.1.4 Will

Is used only to indicate the future not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions

3.2.1 Cylinder

Transportable container of up to 150 litres water capacity that can be filled with gas under pressure.

3.2.2 Pressure

In this publication bar shall indicate gauge pressure unless otherwise noted i.e., (bar, abs) for absolute pressure and (bar, dif) for differential pressure.

4 Guidelines

4.1 Background

Acetylene has been produced in commercial quantities for over one hundred years. As such, it was one of the original industrial gases and is still widely used throughout industry.

Acetylene is a high energy gas which is unstable when compressed in its free state. To ensure safe storage, it is dissolved under pressure in a suitable solvent. The most commonly used solvent is acetone for single cylinders and dimethylformamide (DMF) for cylinder bundles, although dimethylformamide has been used as an alternative for cylinders for some specific applications. All acetylene cylinders are filled with a porous material into which the solvent (acetone or DMF) is absorbed. The acetylene dissolves in the solvent which holds the acetylene in a stable condition.

The porous material is a complex matrix which must satisfy certain basic requirements:

- an ability to stop decomposition of the acetylene caused by 'flashbacks' in the system;
- a stable structure over a long period of time to prevent the creation of voids or cracks in the matrix for example by rough handling of the cylinder;
- a uniform structure which completely fills the cylinder volume; and
- a high porosity to ensure optimum fill ratios of the cylinders.

The first three points are crucial for the safe operation of acetylene cylinders. Defects would lead to instability and, in extreme cases, failure of the cylinder.

Measurements have demonstrated that no asbestos fibres are emitted during the discharge of acetylene from the cylinder. The safety benefits of using these asbestos containing porous materials have been proven by more than 30 years of use. Also, the quantity of asbestos in a typical acetylene cylinder is very small:

- The porous material occupies approximately 7 to 13% of the total volume of the cylinder.
- Asbestos is approximately 10% of the volume of the porous material.
- Hence, asbestos represents less than 1% of the cylinder volume.

As a result of developments in porous materials, the development of an asbestos free porous material become possible in the early 1990s. These porous materials have the same benefits and degree of safety as the asbestos based porous materials.

New cylinders no longer have any asbestos content in the porous material. Changes in European legislation prevent acetylene cylinders containing asbestos being placed on the market in Europe. Existing cylinders with the porous material containing asbestos may still be used providing they are in good condition and where this is allowed by the relevant national or international legislation.

Acetylene cylinders are high integrity high strength containers, made in accordance with relevant national and international standards or regulations. Any asbestos is therefore in a closed system and the cylinders still in service can be used to the end of their operational lives. Industry efforts should therefore be directed to the safe treatment or disposal techniques for any damaged or obsolete cylinders.

4.2 Objectives

This publication reflects the principles of duty of care for dealing with waste. Duty of care requires that all reasonable steps are taken to look after any waste generated and that illegal disposal by others is prevented. Additionally, disposal of potentially hazardous waste should be consistent with Best Available Techniques Not Entailing Excessive Costs, otherwise known at BATNEEC.

This publication's guidelines have been developed to reflect the experience from EIGA companies.

The publication applies to the treatment or disposal of all designs of acetylene cylinders, including those not containing asbestos.

4.2.1 Principles

EIGA member companies who wish to are obliged to show an equivalence of safety to the containment of the cylinder in a licensed landfill. The main objectives of this publication are to show how:

- an equivalence of safety can be maintained;
- how the safety and environmental hazards can be controlled; and
- how the risks of the different treatment and disposal methods can be controlled.

Cylinders shall not be disposed of while they contain solvent since subsequent corrosion of the cylinder can cause the solvent to leak out. This can cause long term environmental problems. Provided that the asbestos is contained until after it has been stored in a suitably designed and licensed landfill site, it presents no pollution potential to any environmental medium. However, long-term liabilities associated with placing the cylinders in landfill shall be taken into account.

4.2.2 Code of practice history

The publication includes various methods of treatment or disposal and reflects changing legislative requirements. These methods have been included to reflect the philosophy behind the Landfill Directive (Council Directive 1999/31/EC *on the landfill of waste*) [1].[1] Landfill space is declining within the EU. In some countries the disposal to landfill of the cylinder with the porous material sealed within the cylinder is not acceptable even with the solvent removed. This is due to the legal pressure to recover recyclable materials and to treat waste before it is sent to landfill. Additionally, in some countries the waste remains the property of the producer, even following correct disposal.

This publication reflects advances in the techniques for the destruction of asbestos. Any method that recovers the cylinder by removing or destroying the porous material shall meet the criteria of the equivalence of safety and all the environment, health and safety risks shall be identified and controlled.

4.3 Selection of cylinders for treatment or disposal

A flowchart of the process described in 4.3 to 4.5 is provided in Appendix A.

4.3.1 Reasons for treatment or disposal

There are normally four possible reasons for disposing of cylinders:

- External condition – the cylinder shell could have been subjected to fire or physical damage and failed the inspection at time of filling, see ISO 11372, *Gas cylinders – Acetylene cylinders – Filling conditions and filling inspection* [2].

- Internal condition – for example contamination by water, carbon black, broken porous material.

- Commercial decision – for example the cylinder design has been superseded by a more recent design.

[1] References are shown by bracketed numbers and are listed in order of appearance in the reference section.

- Periodic inspection – failed to satisfy the prevailing periodic inspection requirements for example expiry date of the porous material, see ISO 10462, *Gas cylinders – Acetylene cylinders — Periodic inspection and maintenance* [3].

4.3.2 Identification

Whatever the cause of rejection the cylinders selected for treatment or disposal shall be identified as such, for example painted, or better, stamped with the word "*scrap*" and segregated in a restricted area, separate from the normal operational area.

4.3.3 Records

At this stage a record should be made of the cylinder details. This documentation shall follow the cylinder throughout the treatment or disposal process.

The record system shall be designed such that the treatment or disposal route can be audited in the future.

4.4 Removal of acetylene gas

4.4.1 Records

Check the weight of each cylinder and record the actual weight.

4.4.2 Residual pressure

Check residual pressure. This will result in two possible action routes (see Appendix A for 'flow chart').

4.4.2.1 Positive pressure indicated

Compare the pressure with the fill chart and the actual weight recorded earlier.

Reclaim the acetylene gas as much as possible (acceptable quality) to the minimum practical level of gas pressure in the cylinder, or that the acetylene recovery system can manage. This can be done, for example, by equalising the cylinder pressure to the pressure in the gasholder.

Otherwise, the residual acetylene may be treated via another authorised method. Reference should be made to EIGA Doc 30, *Disposal of Gases* [4]. Acetylene is flammable and considered a Volatile Organic Compound (VOC), as such there may be restrictions on venting.

Weigh the cylinder and compare with the tare weight to ensure the cylinder is virtually empty of gas. A difference in the weight is not always an indication of the presence or absence of gas in the cylinder. Other relevant factors, such as possible excess or loss of solvent, external corrosion or contamination with water, shall be assessed.

The remaining gas in the cylinder should then be discharged to equalise the cylinder pressure with atmospheric pressure. The most convenient and economical method is to dilute the waste gas into the air at a harmless concentration. This shall be carried out in a responsible manner to ensure no hazardous conditions are created, legislative requirements are met and there is no risk of damage to the environment.

Cylinders which have been opened and vented can still release further residual gas if brought into a warmer area (for example brought inside a building having been vented outside in a colder environment), due to the saturation of acetylene in the solvent. This is a potential safety hazard for which suitable precautions should be taken, as the resultant vapour will be saturated with solvent and heavier than air. For example, cylinders can be connected to a vent manifold or kept in a separate area.

During the venting process, the internal temperature of the porous material is reduced and due to its characteristics will take time to warm up again and be equalised with the room temperature. As the temperature of the solvent is also reduced, its capacity of absorbing the gas will increase. A good practice is to keep the cylinder for 24 hours to allow it to warm-up again before checking the pressure.

4.4.2.2 No pressure indicated

The absence of a positive pressure reading does not necessarily indicate the absence of excess gas due to the possibility of a blocked valve. It is therefore essential to check for a blocked valve or filter pad.

A suitable method to check this is the introduction of compressed nitrogen (or other inert gas) at a pressure below 1 bar and observing its discharge. This can be achieved, for example, by the arrangement shown in Appendix B:

- Valve A is closed.
- Valve B is opened until gauge P registers 1 bar.
- Valve B is then closed. If the indicated pressure does not decay i.e. there are no leaks in the connections.
- Valve A is then opened. Rapid decay of indicated pressure indicates valve A is not blocked as the gas in the manifold flows into the cylinder.

If the valve is suspected of being blocked or inoperative then refer to EIGA Doc 129, *Pressure Receptacles with Blocked or Inoperative Valves*, and EIGA Doc 30, or ISO 10462 [3, 4, 5].

The valve design shall be considered and appropriate precautions taken with regard to the properties of the cylinder contents.

If there is no evidence of a blockage (valve or filter pads), or after any blockage has been dealt with, vent any residual gas.

4.4.3 Removal of valve

Once the cylinder has been successfully emptied of acetylene gas the cylinder valve can be removed.

***WARNING**: All operations involving recovery or venting of acetylene gas shall be carried out in a suitable and defined safe area where the risk for an explosive atmosphere has been assessed and any necessary protective measures implemented. Also, after the gas has been vented there will still be some saturated gas in the solvent. Do not let acetylene cylinders stand unattended for any excessive period of time without a valve or plug fitted, flammable vapours can be released. Acetylene and acetone vapours can be heavier than air and collect at low levels creating a fire or explosion risk. Only remove one valve at a time.*

4.5 Solvent removal

Although many solvents may be used with acetylene the two most commonly used are:

- acetone; and
- dimethylformamide (DMF).

It is strongly recommended that these solvents be reduced to the lowest practicable quantity, particularly in the case of DMF. Acetone and DMF are considered volatile organic compounds (VOCs), combined with their other properties there can be restrictions on venting.

Wherever possible, the first step is to identify the solvent in the cylinder. This is normally indicated by the stamping on the cylinder. Reference should then be made to the Safety Data Sheet for the contained solvent and the corresponding risk assessment so that recommended personal protective equipment can be selected. See also EIGA Doc 136, *Selection of Personal Protective Equipment* [6].

Remove all fusible plugs / safety devices, where these are fitted, from the cylinder and securely refit blanking plugs on the openings.

WARNING: *Solvents will only be partially removed by cylinders being left open in the open air for any period of time due to poor heat transfer, as the cylinder contents are not held above the boiling point of the solvent.*

4.5.1 Acetone

Heat the cylinder(s) uniformly to at least 150 °C for a minimum of 12 hours at atmospheric pressure. This can be achieved, for example, by the use of hot air circulating ovens.

Alternatively, the necessary heating can be achieved by immersing the cylinders in a water bath at 85 °C for a minimum of 12 hours, or by using heated jackets. In both cases the solvent should preferably be recovered in a condenser or, if this is not technically or economically possible, vented to a controlled location.

The temperature can be reduced and / or the time shorted by utilising vacuum to lower the boiling temperature of the solvent. In all cases the outside temperature shall be sufficient ensure the internal cylinder temperature is maintained above the boiling point of the solvent and the time sufficient to remove solvent to the lowest practicable level. Care shall be taken that equipment used to create a vacuum is suitable for use with the solvent and does not cause an ignition.

4.5.2 Dimethylformamide (DMF)

Heat the cylinder uniformly to at least 250 °C for 24 hours. This can be achieved, for example, by use of hot air circulating ovens. The use of a jet pump, operated with cooled solvent will assist the evaporation of solvent by creating a partial vacuum although, this can be hazardous as the solvent will absorb any acetylene, concentrating it and possibly creating a fire or explosion risk.

WARNING: *DMF can give rise to problems including toxicity and possible plugging of process lines with white solid products due to polymerisation*.

The temperature can be reduced and / or the time shorted by utilising vacuum to lower the boiling temperature of the solvent. In all cases the outside temperature shall be sufficient to ensure the internal cylinder temperature is maintained above the boiling point of the solvent and the time sufficient to remove solvent to the lowest practicable level.

If there is any doubt about the system design and operation, then expert advice shall be sought.

4.5.3 Reclaiming of solvents

Reclaim the extracted solvents either for future recycling or authorised disposal.

NOTE Saturation gas will also be released.

Where reclamation and recycling are not possible, the following general principles for the treatment or disposal of acetone or DMF shall be followed, the solvent shall be:

- securely contained;
- clearly labelled;
- separated from other wastes;
- handled with care;

- transferred only to a licensed waste carrier; and

- disposed of only to a licensed waste site.

Personal protective equipment (PPE) identified in the risk assessment or SDS shall be used.

CAUTION: *The operation shall be subject to a risk assessment. In particular, the equipment needed for recycling or reclamation shall be designed and operated taking into account the properties of the solvent and the possible release of any residual dissolved acetylene and the subsequent risk of ignition for example any storage of solvent should be blanketed with inert gas or be protected in other ways appropriate to the flammability of its contents.*

4.6 Acetylene cylinder waste management methods

4.6.1 Selection of acetylene cylinder waste management methods

Methods that are in use for the treatment or disposal of acetylene cylinders are described below. It is important to note that before final treatment or disposal it is strongly recommended that all cylinders contain the minimum practical level of solvent and acetylene. This can be achieved by following the steps set out in sections 4.3 to 4.5. A summary of the methods is provided in Appendix C.

Some references are made to patents on the processes discussed. It is strongly advised that the patent status of any process be checked before designing and implementing a particular solution.

Local, national and international regulations shall be followed. In particular, regulations for waste treatment or disposal shall be identified and understood. Specific permits are required for installations where exposure to asbestos fibres is possible.

Cylinders sent for treatment or disposal shall follow the regulations for shipments of waste. This involves pre-notification to, and agreement with, the authorities in the region or country of destination for treatment or disposal. This also follows the proximity principle set down in EU law that waste should be disposed of as close as possible to the point of generation, to minimise the environmental effects and risks of transport.

According to Commission Decision 2000/532/EC *establishing a list of wastes*, the following waste code shall be used: 15 01 11 *metallic packaging containing a hazardous solid porous matrix (for example asbestos), including empty pressure containers* [7].

In countries or regions where the facilities exist, the recyclable cylinder shell can be recovered, followed by safe containment of the porous material in licensed landfill.

The objective of this publication is to maintain an equivalence of safety to the safe containment of the cylinder and porous material in licensed landfill, whilst recognising that there are environmental benefits to recovering the recyclable cylinder shell and avoiding landfill and possible associated liabilities.

The Landfill Directive reduces the acceptability of landfill as a solution [1]. As part of the implementation of this directive there is an EU decision establishing criteria and procedures for the acceptance of waste at landfill pursuant to article 16 and annex II of the Landfill Directive [1].

In accordance with the acceptance criteria, there is a requirement that waste is treated before sending to landfill. For acetylene cylinders with asbestos porous material this involves, as a minimum, removal of the solvent in accordance with section 4.5. In some countries the cylinder shell also requires removal for recycling before landfill of the porous material is acceptable.

The proximity principle that waste should be treated and disposed of as close as possible to the point of production and safety considerations shall be balanced with the desirability of recovering the cylinder shell.

When the porous material is removed from the cylinder, this requires very stringent control for the removal process to ensure that workers are not exposed to unacceptable levels of asbestos fibres and so that no asbestos fibres will be released into the environment.

The philosophy of this publication is that any asbestos used in the construction is contained within the cylinder shell as part of the treatment or disposal process unless an equivalence of health and safety can be demonstrated by an alternative treatment or disposal process. Removal of the porous material by untrained personnel can lead to safety and / or environmental hazards.

4.6.2 Selection of waste contactors

Waste contractors shall be selected to comply with the waste duty of care. Technical considerations that shall be checked include:

- competence and training of the contractor;
- valid licences or permits for contractor carrying out the activity; and
- financial viability of the contractor.

The waste producer may still retain liability for the waste if the contractor is not financially sound or becomes financially insolvent.

4.6.3 Treatment or disposal

Acetylene cylinders scrapped according the procedure in this publication are regarded as hazardous waste. Due regard shall be given to taking all reasonable steps to look after any waste and prevent its illegal treatment or disposal by others. This is commonly known as duty of care. This applies when disposing of scrap acetylene cylinders. National legislation within individual countries may require specific actions on the part of persons disposing of such cylinders which shall be complied with. In general, the minimum requirements are:

a) Correct labelling and description of the waste (i.e. cylinders and residual contents).

b) Transfer only to a licensed waste management facility who is capable of dealing with the waste correctly. Permission from the competent authority can be required prior to treatment or disposal. In this case normal good practice requires the following details:

- what the waste is and how much there is;
- the time and date the waste was transferred to the treatment or disposal facility;
- where the transfer took place;
- the names and addresses of both parties;
- if either or both parties, as a waste carrier, has a registration certificate, the certificate number and the name of the authority that issued it; and
- if either or both of the parties have a waste licence, the licence number and the name of the authority that issued it.

c) Treatment or disposal only to a licensed waste management facility capable of accepting the waste.

d) Periodic review of waste treatment or disposal contractor operations.

e) Production and retention of records of disposal.

Compliance with relevant national legislation shall be regarded as the minimum acceptable standard.

4.6.4 Records

In most countries the record keeping for the treatment or disposal of hazardous waste is clearly stipulated. However, the following points shall be included to ensure that the treatment or disposal process can be reliably audited:

- cylinder details;
- transport contractor and licence details;
- treatment or disposal site and approval / licence details;
- treatment or disposal date;
- records of the reviews of transport and treatment or disposal contractor operation regarding scrap acetylene cylinders; and
- records of disposal of the different wastes generated by the process (porous material, cylinder, solvent etc).

4.6.5 Landfill of cylinder plus porous material

4.6.5.1 Rendering cylinder unfit for further use

After following 4.3 to 4.5, i.e. removing the acetylene and solvent to the lowest practicable level, it is essential that precautions are taken to ensure that these cylinders are not returned to service in the future.

This is necessary to prevent less responsible persons or organisations who may wish to benefit by attempting to re-use such cylinders.

4.6.5.2 Cylinder neck

The most effective way to prevent a scrapped cylinder being reused is to permanently damage the internal neck thread. This can be achieved during the plugging of the neck using, for example:

- an oversize plug hammered into the neck and then welded; or
- a plug welded into the neck in such a way as to destroy the threads during welding.

NOTE Welding can cause an ignition if some acetylene / acetone is present.

Any practical method may be used which achieves the twin aims of thread destruction and sealing the cylinder neck, for example:

- severely damaging the neck and seal the neck with suitable concrete; or
- thread locking a plug into the cylinder and shearing off the plug drive so that it is flush with the top.

NOTE Non-sparking tools should be used in any thread damaging operation.

4.6.5.3 Cylinder marking

Existing cylinder marking shall be obliterated in accordance with prevailing standard. Also, the cylinder shall be stamp marked saying it is scrapped. This is to further ensure that the cylinder cannot be returned to service.

It is considered that cylinders treated in this way present no risk to the environment, and no health and safety risk to people.

4.6.6 Landfill of porous material after removal from cylinder

4.6.6.1 Dry removal of porous material

The acetylene and solvent in the cylinder shall be removed following steps described in 4.3 to 4.5.

The cylinder is then cut open so that the porous material can be removed by mechanical means. This shall be carried out under carefully controlled conditions in a purpose-built facility. The porous material is then double bagged, suitably labelled or identified and removed to a licensed waste treatment or disposal facility in accordance with the duty of care principles outlined in 4.6.3 and 4.6.4.

The facility shall be designed to ensure that all asbestos fibres are contained and that operating personnel are not exposed to these fibres at any time, according to established occupational health standards. This can be achieved by remotely operated cutting equipment in a sealed air locked room. This will maintain an equivalence of safety to the containment and burial of cylinder plus porous material.

4.6.6.2 Wet removal of the porous material

The acetylene and solvent in the cylinder shall be removed following steps described in 4.3 to 4.5.

The solvent shall first be removed to prevent contamination of the water used in the porous material removal process. Acetone forms an azeotropic mixture with the water which makes it difficult to treat this water.

A water jet is used to remove the porous material from the cylinder in an area designed to contain the resulting slurry, which shall be disposed of as hazardous waste in accordance with the duty of care principles outlined in 4.6.3 and 4.6.4. No emissions of asbestos fibres into surface water or sewers are permitted so the fibres must be collected before discharging to water.

4.6.6.3 Cutting the cylinder without solvent removal

The acetylene in the cylinder shall be removed following steps described in 4.3. Normally, the solvent is also removed as this is the best way to prevent contamination by the solvent and safety / handling problems.

Removal of the porous material without removing the solvent is only acceptable if an equivalence of safety and environmental protection can be shown, i.e. this is only acceptable when there is adequate control of the porous material which is saturated with solvent.

All acetylene cylinders are treated by a full automatic process in a closed container which is protected by vacuum (~ 0.5 bar, abs). The cylinder is picked up and cut into two pieces. The porous material is separated from the steel cylinder inside the closed container and the acetylene cylinders are not pre-heated. This is only acceptable when there is adequate control of the porous material which is saturated with solvent. The solvent shall be recovered or vented when the porous material is pressed out. Sending porous material to landfill that is contaminated with solvent is prohibited as it does not meet the Landfill Directive waste acceptance criteria on leachability of waste [1].

The porous material is pressed out and collected in a bag. The bag is closed automatically and transported to the disposal site or for further usage.

The steel cylinder is cleaned by means of washing with a special fluid to ensure no fibres remain on the steel itself.

4.6.7 Treatment by dissolving the porous material with hydrogen fluoride (HF)

The acetylene and solvent in the cylinder shall be removed following steps described in 4.3 to 4.5. The cylinders are internally treated with hydrogen fluoride in a purpose-built facility.

This dissolves the asbestos porous material and means that the cylinder shell can be completely recovered. This process is subject to a patent by Solvay S.A. but is not currently in use.

4.6.8 Disposal in high temperature conventional furnace

The acetylene and solvent in the cylinder shall be removed following steps described in 4.3 to 4.5.

The cylinders can then be added in a controlled manner to a blast furnace or be treated in a plasma furnace. Provided the temperature exceeds 1200 °C, this process results in the complete destruction of the asbestos fibres. The furnace shall have the correct licenses and controls for disposing of cylinders in this way. Some parts of the blast furnace disposal process are subject to a patent from Linde AG.

4.6.9 Dissolving the porous material by chemical reaction in an autoclave

The acetylene and solvent in the cylinder shall be removed following steps described in 4.3 to 4.5. The porous material shall then be removed from the cylinder following the method set out in 4.6.2.1.

The principle of the process is chemical reaction with sodium hydroxide (NaOH) at 100 °C for 35 minutes. This causes the breaking of the bond structure and complete dissolution of the fibres.

Sodium hydroxide (NaOH) is added to water in an autoclave and heated to 160 °C. Addition of NaOH is automatically controlled by pH measurement. Bags of waste are loaded into an autoclave without sorting. NaOH solution is transferred and the reaction allowed to proceed. Liquid / solid separation is achieved by centrifuge. Liquids go back into the system. Solids are drained and used according to their nature. Waste is rinsed and pH balanced where necessary.

The solid waste contains no fibres. Where no uses can be found for this, it can be treated as ordinary building rubble and disposed of accordingly. No vapours are produced.

Solid waste is the residue from the process. NaOH is the prime raw material and there are no liquid effluents. This process adopts a chemical reaction with no obvious solvent usage.

This process is not currently in use.

4.6.10 Disposal in high temperature induction furnace

The acetylene and solvent in the cylinder shall be removed following steps described in 4.3 to 4.5.

Provided the correct precautions are taken the heating in the furnace can be used to remove the solvent and residual acetylene.

The cylinders can then be added in a controlled manner to an induction furnace, the cylinder and porous material are melted in the furnace. Provided the temperature exceeds 1200 °C this process results in the complete transformation and destruction of the asbestos fibres. The furnace shall have the correct licenses and permissions.

4.6.11 Polymer encapsulation

The acetylene and solvent in the cylinder shall be removed following steps described in sections 4.3 to 4.5.

The asbestos porous material is then removed using method in 4.6.6.1. A specific chemical is mixed with asbestos to encapsulate the fibres and form a non-hazardous residue.

This process is at a concept stage and not currently in commercial operation.

5 References

Unless otherwise specified, the latest edition shall apply.

[1] Council Directive 1999/31/EC *on the landfill of waste*, www.europa.eu.

[2] ISO 11372, *Gas cylinders – Acetylene cylinders – Filling conditions and filling inspection*, www.iso.org.

[3] ISO 10462, *Gas cylinders – Acetylene cylinders — Periodic inspection and maintenance*, www.iso.org.

[4] EIGA Doc 30, *Disposal of Gases*, www.eiga.eu.

[5] EIGA Doc 129, *Pressure Receptacles with Blocked or Inoperative Valves*, www.eiga.eu.

[6] EIGA Doc 136, *Selection of Personal Protective Equipment*, www.eiga.eu.

[7] Commission Decision 2000/532/EC *establishing a list of wastes*, www.europa.eu.

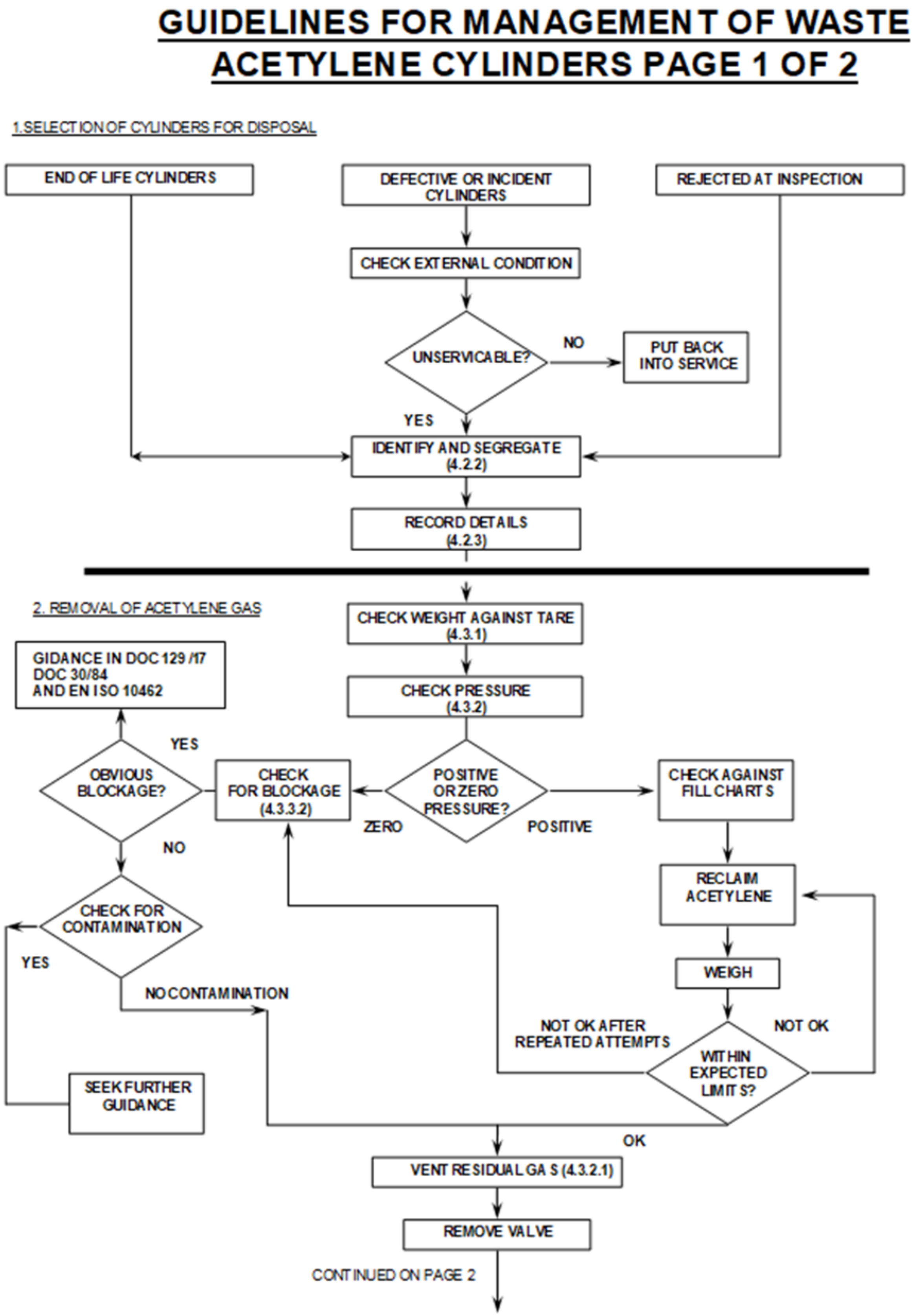
6 Additional references

EIGA Doc 26, *Permissible Charge / Filling Conditions for Acetylene Cylinders, Bundles, Battery Vehicle*, www.eiga.eu.

EIGA Doc 109, *Environmental Impacts of Acetylene Plants*, www.eiga.eu.

EIGA Doc123, *Code of Practice – Acetylene*, www.eiga.eu.

Appendix A: Flowchart – Management of waste acetylene cylinders



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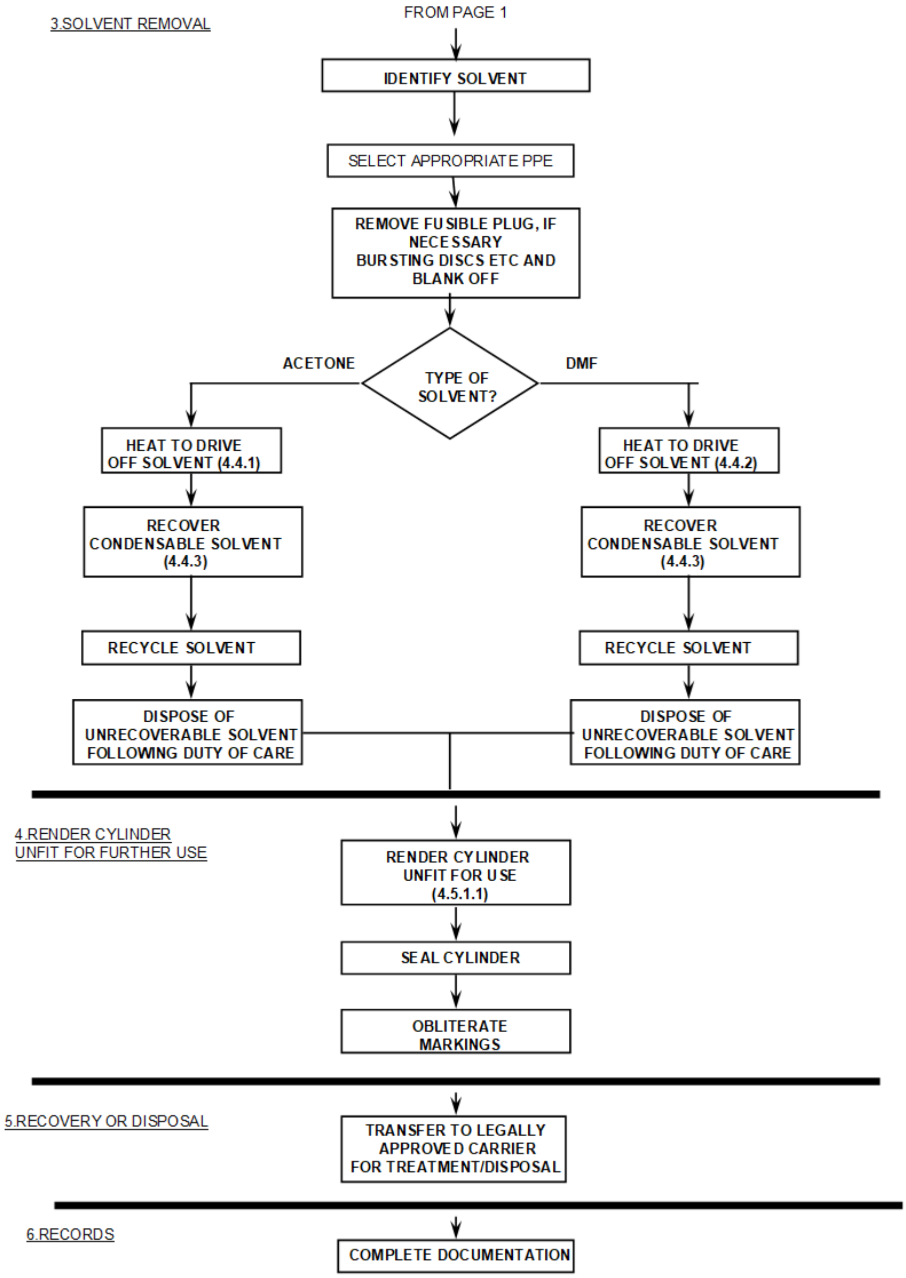
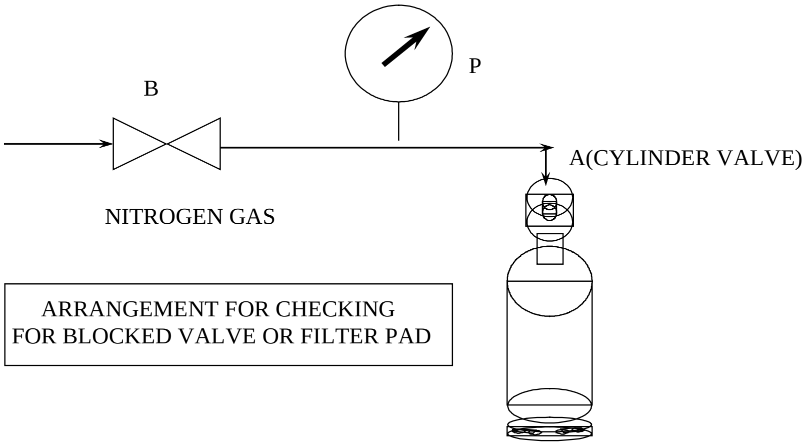
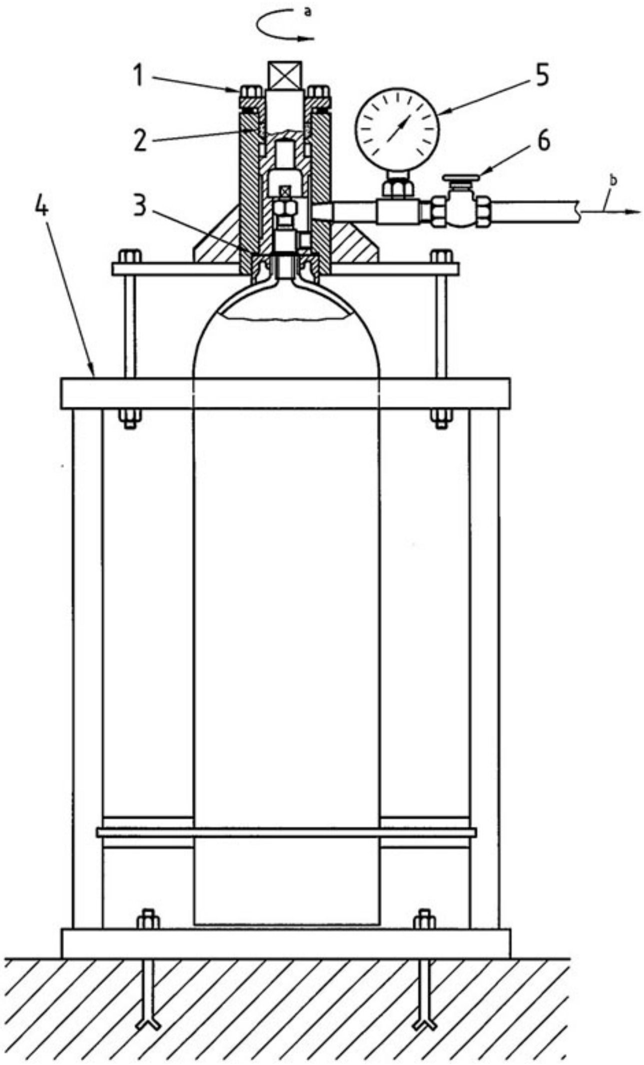


Appendix B: Apparatus for handling blocked valves



When a cylinder is found to have an obstructed gas passage in the valve, the cylinder shall be set aside and handled only by specifically trained personnel in this task. The preferred method to follow is to partially unscrew the valve within a glanded cap that is secured and joined to the cylinder and vented to a safe discharge. For further information see EIGA Doc 129 [5].

The principles of a suitable device are illustrated in following figure. This procedure shall be performed in a controlled manner in such a way as to avoid personal injury.



Key

1 drive for de-valving machine
2 gas-tight gland
3 gas-tight seal
4 cylinder frame and clamping device
5 pressure gauge
6 vent valve

a Direction of rotation.
b To gas disposal.

Appendix C: Advantages and disadvantages of each process

NOTE Cylinders shall be treated in accordance with 4.3 to 4.5.

	Method	Advantages	Disadvantages
1	Landfill cylinder plus porous material	No asbestos exposure Proven method Low cost	No recovery Potential landfill liabilities Not permitted in Belgium and Netherlands Landfill leachate Pressure on landfill space / public perception Shall to comply with landfill acceptance criteria 4.6.3
2	Landfill dry porous material	Recovery of steel Proven method Low cost	Control of workplace asbestos Potential landfill liabilities Landfill leachate Shall comply with landfill acceptance criteria 4.6.3
3	Landfill wet porous material	Recovery of steel Proven method Low cost	Control of asbestos in water Water pollution if solvent not removed Control of workplace asbestos Transport of waste Landfill leachate Potential Landfill Liabilities Shall comply with landfill acceptance criteria 4.6.3
4	Cutting cylinder without removing solvent	Cost saving by missing out solvent removal step Reuse/recovery of cylinder	Control of solvent Shall comply with landfill acceptance criteria 4.6.3
5	Hydrogen fluoride process (dissolve porous material)	Pilot only Reuse / recovery of cylinder No transport of waste necessary End products are harmless	High cost Acid handling during process Disposal of waste No facilities Not currently used in practice
6	Plasma furnace	Proven method Complete vitrification	High cost Control of workplace asbestos required Current capacity Explosion risk if solvent not removed
7	High temperature conventional furnace	Proven method Energy is recovered from the waste	High cost High temperature required to destroy fibres Control of workplace asbestos required Acceptability to companies owning furnaces Approval authorities / public Explosion risk if solvent not removed
8	Sodium hydroxide	Medium cost Reuse / recovery of cylinder No transport of waste necessary End products are harmless	Method not proven on cylinders Control of workplace asbestos required Alkali handling during process Permit required for gas site

	Method	Advantages	Disadvantages
9	High temperature induction furnace	Proven method on pilot scale Energy is recovered from the waste No waste end product – slag is recycled Solvent need not be removed	High cost High temperature required to destroy fibres Control of workplace asbestos required Approval authorities / public
10	Polymer encapsulation	Reuse / recovery of cylinder End products are harmless	High cost