BEST AVAILABLE TECHNIQUES FOR ACETYLENE PRODUCTION

Doc 226/20

EUROPEAN INDUSTRIAL GASES ASSOCIATION AISBL

AVENUE DES ARTS 3-5 • B – 1210 BRUSSELS
Tel : +32 2 217 70 98 • Fax : +32 2 219 85 14
E-mail : info@eiga.eu • Internet : www.eiga.eu

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Prepared by WG-5 Environment

Disclaimer

EUROPEAN INDUSTRIAL GASES ASSOCIATION AISBL
Avenue des Arts 3-5 B 1210 Brussels Tel +32 2 217 70 98 Fax +32 2 219 85 14
E-mail: info@eiga.eu Internet: www.eiga.eu

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1. Introduction

This EIGA publication provides guidance to EIGA members specifically to site managers, technical managers, and company environmental specialists on some best available techniques for acetylene production by wet hydrolysis, which is the principal method used to produce acetylene for distribution in cylinders and packs for welding and other applications. It represents the EIGA contribution to the EU Best Available Technique Reference Document (BREF) [1] being organised by the European IPPC Bureau. Local legislation shall also be applied.[1]

2. Scope and purpose

This publication provides guidance on compliance with the Industrial Emissions Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) [2]. This covers acetylene production in Annex I Section 4.1a Production of organic chemicals, simple hydrocarbons and associated BREFs.

The main objectives are to:

- propose techniques deemed as best and available for acetylene production in the industrial gases industry;
- gather data to support conclusions on Best Available Techniques;
- encourage consistency with associated BREFs about acetylene production; and
- contribute to any aspects of the European IPPC Bureau's reference document on large volume organic chemical production.

3. Terminology and definitions

3.1 Publications 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.

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

3.2 Technical definitions

3.2.1 Best Available Technique (BAT)

The most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole.

> (a) 'Techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.
>
> (b) 'Available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator.
>
> (c) 'Best' means most effective in achieving a high general level of protection of the environment as a whole.

3.2.2 Environmental aspect

Elements of an organisation's activities, products or services that can interact with the environment. For example, use of energy or transportation of products.

4. Acetylene production

4.1 Acetylene history and uses

Acetylene and products made by use of acetylene are broadly present in our daily life. In the past it was mainly used for lighting purposes (for example city illumination, vehicle illumination, lighthouses, lighting for mining companies), for anaesthetic treatment in hospitals and for cutting / welding of steel. Today acetylene is a base chemical for a wide range of different products such as coffee capsules, sport shoes and hair spray. Due to its unique properties it is still used for cutting / welding processes, or for pre-heating of metallic components before subsequent treatment. Further applications have been developed over the years, and therefore acetylene is used for premium products for example in the rubber industry as well as in the glass industry.

4.2 Acetylene production process

Acetylene is produced by two different methods:

- reaction of calcium carbide with water in special generators (wet hydrolysis); or
- as a gaseous by-product from cracking crude oils.

The generation of acetylene for compression into dissolved acetylene cylinders is normally carried out in "wet" generators in which carbide is added to an excess of water. The second method is generally used for production of acetylene as a chemical intermediate.

This publication seeks to focus solely on the reaction of calcium carbide with water in special generators. Specifically, it discusses its relative environmental impacts and advantages as a process choice and then describes some of the best available techniques (BAT) that may be used to improve its environmental performance.

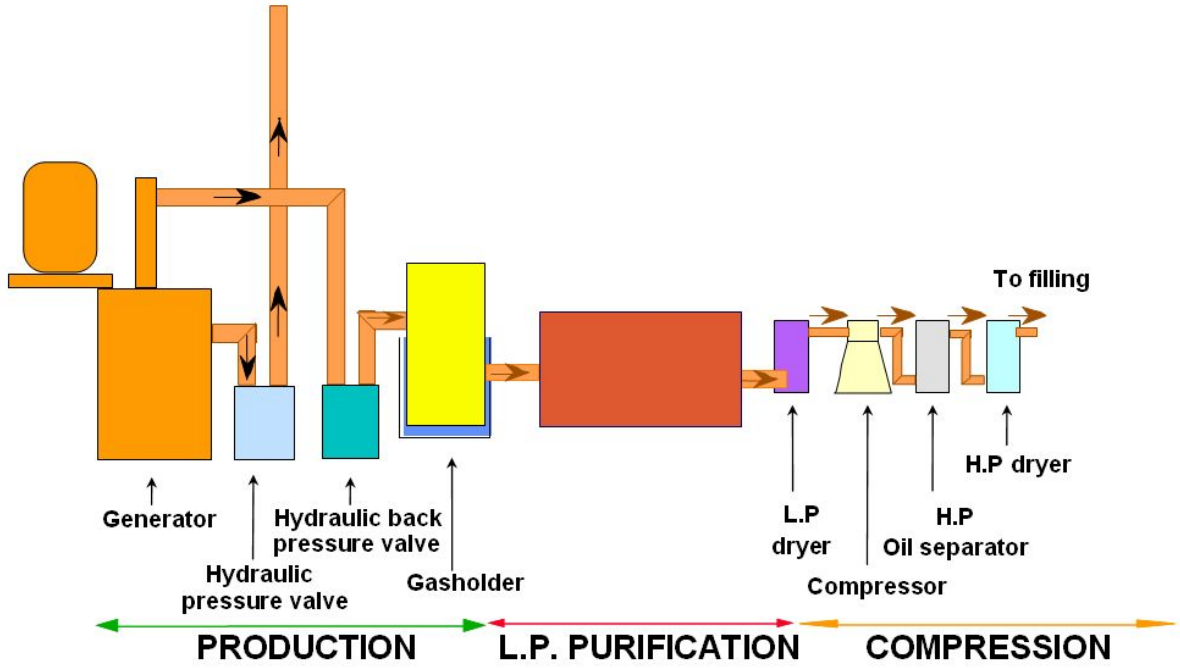

Figure 1: Simplified schematic of acetylene production

4.3 Acetylene process

This publication describes wet hydrolysis, i.e. the exothermic reaction between calcium carbide and water:

$$CaC_2 + 2\,H_2O \rightarrow C_2H_2 + Ca(OH)_2 + 129.9\ kJ$$

Hydrated lime, $Ca(OH)_2$, is produced as a by-product. After separating from the carbide lime, excess decanted water may be reused in the process and the lime can be recovered for use in various industrial or agricultural activities according to applicable local legislation.

Because technical grade calcium carbide contains various impurities from the raw products used in its manufacture (for example coal and limestone) acetylene also contain impurities such as ammonia and phosphine (see EIGA Doc 123 *Code of Practice – Acetylene* [3]).

The generated acetylene is purified, compressed, dried and filled into gas cylinders that are stored on site prior to distribution.

The main environmental impacts from acetylene plants are described in EIGA Doc 109 *Environmental Impacts of acetylene production* [4]. Technical details and safety standards on acetylene production are described in EIGA Doc 123 [3].

5. Existing Best Available Techniques (BAT)

5.1 Acetylene process – Generator

The procedure for charging the generator depends upon the type of system and shall be laid down in specific working manuals and instructions. Two types of generator are used are:

- the ‘open’ generator, where acetylene escapes from the generator during carbide charging; or
- the ‘closed’ generator, where the charging system is sealed.

The open generator causes more emissions of acetylene and other gases (see Section 6).

Operating details and best practices can be found in EIGA Doc123 [3].

The optimum working temperature of the generator (70 °C to 85 °C) gives the maximum yield and therefore the residual acetylene into the lime becomes very small.

5.2 Lime

Using a filter press or a centrifuge to remove excess water can reduce the volume of lime, which makes transport easier and enables a wider variety of uses (see EIGA Doc 143 *Guide to Carbide Lime Applications* [5]).

Lime can be classified as a by-product and not a waste provided if it meets the tests in EU commission guidance COM 2007/59, *Communication from the Commission to the Council and the European Parliament on the Interpretative Communication on waste and by-products* [6], for example when:

- The intention is not to 'discard' the lime from the process but to market it, the lime is produced to a specification and has a safety data sheet according to product legislation (registered or pre-registered under REACH).

- Lime can be used directly without further processing, which should mean it is not classified as waste if it has a certain beneficial application.

In the unlikely event of no available use for the lime, it shall be disposed of as waste according to amending Decision 2000/532/EC, *Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste* [7] (waste number 06 02 01 for $Ca(OH)_2$). Permission from competent authorities is required.

Examples of uses include:

- in industries where spent acids and waters with low pH-value require neutralisation (lime is an excellent neutraliser);

- sewage water treatment;

- flue-gas purification;

- use as corrector of pH-value of soil (agriculture);

- building trade (mortar processing); or

- chemical processes.

Lime slurry should be considered as a by-product and not as a waste, because it is possible to market it for different uses (see EIGA Doc 143 [5] and ASTM Special Technical Publication STP 931 *Lime for Environmental Use* [8]). Regular analysis should be carried out to promote lime as a product.

Lime slurry contains small quantities of dissolved acetylene, which can be released if vacuum pumping systems are used to load road tankers. This requires careful consideration as part of the task risk assessment using a flammable zone rated vacuum pump if required.

5.3 Generator water – Water reuse

Water that is used in the acetylene generator (excluding the water that remains with the lime) should be re-circulated after separation from lime. Rainwater or blow down water from cooling water systems can also be used as generator water after having been filtered and analysed.

Lime water shall never be drained uncontrolled into the sewage water system or ground water. Releasing lime water into the drainage or public sewage water system will cause problems due to its high pH-value.

Before draining the water, the local sewage water authorities shall be asked for permission and a method (depending on the sewage water composition) shall be agreed. This water may also contain ammonia, which is highly toxic to fish and shall not be discharged directly to rivers.

5.4 Cooling water

Recycling of cooling water is recommended.

If cooling water does not contain any impurities it may drain it into the rainwater drainage or sewage water system in accordance with national or local regulations, for example requirements for pH-value or temperature (various countries need permission for this).

If cooling water is contaminated with oil or other chemicals (closed circuit cooling system) the procedure of draining the cooling water into the sewage water system shall be arranged in accordance with methods accepted by the local authorities.

Often chemicals such as biocides are added to prevent the development of legionella and other anti-fouling chemicals may also be added. Care shall be taken to prevent operator exposure to breathing overspray water containing these biocides, as they are hazardous to health.

Where it is practical and economic rainwater may be used for cooling water.

5.5 Purification

Acetylene contains impurities, i.e. phosphine, ammonia, hydrogen sulphide and organic sulphides. Purification involves the removal of these components by scrubbing and / or oxidation. Purification takes place in relatively narrow and tall washing towers to ensure an intensive contact between cleaning agent and gas or by passing the gas through beds of solid purification material. Sulphuric acid, sodium hydroxide and sodium carbonate are mostly in use as purification agents.

There are two principal methods for purifying the gas:

- use of dry purification beds containing ‘Fullers Earth’ or similar material; or
- use of wet purification systems.

Wet purification by acid washing represents the best available technique as it removes the need for the use of solid purification material (which generates a hazardous solid waste), and the acid can be fully and safely neutralised. In addition, this process is more energy efficient as there is less pressure drop though the process, avoids air emissions during the purification step and gives the best quality of acetylene (pH3 can reach 1 ppm and less, better than dry purification process). Both products (acid and soda) are chemicals that require rigorous safety management.

5.6 Optimising cylinder filling

Acetylene is dissolved under pressure in cylinders which contain approved porous mass and a solvent that is either acetone or dimethylformamide (DMF). During cylinder filling no significant emission of acetylene occurs. The acetylene solubility depends on various parameters (quality of porous mass, quality of solvent, quantity of solvent maintained according to the manufacture design, efficiency of cylinder cooling during its filling etc.). For safety reasons every cylinder is weighed after filling to ensure that it is correctly filled. Each acetylene cylinder overfilled shall blow-back on a special emptying manifold to generator or gasholder until it reaches the nominal range of charge.

DMF or acetone emissions from storage can be minimised by use of vapour recovery or closed cycle during tank filling.

5.6.1 Description

Pressurised cylinders are filled with acetylene gas and solvent in a staged process that is closely monitored by a control unit to assure that filling progresses with all critical variables maintained within safe bounds. An operator performs certain preliminary cylinder hook up tasks as monitored and prompted by the control unit. The control unit conducts the actual filling of the cylinder, carrying out this procedure in distinct filling stages with alternate injections of solvent and gas into the cylinder. The improved system enhances the safety and efficiency with which acetylene cylinders are filled.

5.6.2 Applicability

The filling of acetylene cylinders involves problems beyond those normally encountered in filling cylinders with gases other than acetylene. When an acetylene cylinder is returned from a customer, it contains an unknown quantity of residual acetylene gas and an unknown quantity of solvent. The quantity of solvent remaining in the cylinder is almost always less than the required nominal amount due to discharge of evaporated solvent from the cylinder as acetylene gas is used by the customer. (the difference is dependent on the end use of acetylene).

5.6.3 Achieved environmental benefits

By weighing a returned cylinder, it is possible to determine the total weight of the cylinder and such solvent and residual gas as remain in the cylinder. By measuring the pressure of the contents of the cylinder and by considering the temperature of the cylinder the exact quantities of residual gas and solvent present in the cylinder can be calculated. Any cylinders showing excess weight after filling are slightly emptied. Any cylinders which have been insufficiently filled are topped up.

5.6.4 Cross-media effects

Filling with higher than required weight of acetylene, and some filling with a lower than the required weight of acetone or DMF. Any cylinders showing excess weight of acetylene charge than required are slightly emptied, leading to increased air emissions and energy use.

5.6.5 Operational data

Fill the right amount of solvent and acetylene in the first place reduce the use of energy and the emissions to air.

5.6.6 Economics

Filling the right amount of solvent and acetylene in the first place reduces the use of energy and the emissions to air and hence also cost.

5.6.7 Driving force for implementation

Filling to the correct weight improves energy efficiency, reducing greenhouse gas emissions and leads to fewer air emissions.

6. Additional BATs to address emissions to air

6.1 Sources of emission

Acetylene is a volatile organic compound (VOC) with a low ozone creation potential.

Typical emission sources of an acetylene plant are:

- generator (open or closed system);
- lime pits;

- gasholder;
- purification unit;
- compressors;
- filling station; or
- cylinder maintenance.

Methods for estimating the air emissions from an acetylene plant is given in EIGA Doc 84 *Calculation of Air Emissions from an Acetylene Plant* [9].

6.2 Acetylene emissions – air

Acetylene is an organic gas that contributes to the formation of photochemical oxidants and predicted warming of the atmosphere. It is therefore classified as a Volatile Organic Compound (VOC). Specific legal requirements on VOC emissions reporting may exist depending on the country.

BAT is to return Acetylene from overfilled cylinders or from cylinders being prepared for testing into a closed piping system and return it to the gasholder generator or compressor.

As a general principle of environmental protection and for safety reasons only very small amounts of acetylene should be allowed to escape into the atmosphere. When starting the generator, the acetylene plant and during plant maintenance, acetylene emissions to the atmosphere due to efficiency quality specifications shall be kept at the minimum.

6.3 Process emissions

The main potential air emissions sources are:

- acetylene (plus trace impurities) from vents, generator, condensate drain from compressor, oil separator and HP dry, filling racks, compressors and lime pit;
- carbide dust from the carbide hopper, carbide drums; and
- acetone or DMF from the storage tank vent and during replenishing operation.

Design features that eliminate air emissions are:

- closed generator;
- wet purification;
- recycling water (containing dissolved acetylene) back into the process; and
- installing gas detection systems and leak detection.

Air emissions from the generator are eliminated as the generator is designed as a closed system. Emissions are prevented and minimised by efficient operation of the plant according to the operating procedures, and the plant gas detection to detect leaks or emissions immediately. All the equipment operations are also managed through the relevant operating procedures and the equipment maintained through the preventive maintenance programme

The choice of wet purification also eliminates potential air emissions from the purification step (dry purification needs the regeneration which is the source of acetylene to air).

One of the reasons for recovering additional water from the lime by-product is to recover the additional acetylene dissolved in it.

The small amounts of acetylene and trace gases that are vented to the atmosphere (from the generator, carbide bins, hopper, low pressure equipment, high pressure equipment and compressors, filling) are the result of purging the systems for safety reasons for carbide charging and plant maintenance. Recovering the acetylene, with the nitrogen contaminant, would not be possible or economic. Installation of a flare for this gas would be both expensive, provide a source of ignition, and is unacceptable for safety reasons. Venting this small amount of acetylene and trace gases is therefore the BAT.

The fill hoses and high pressure pipe, high pressure vessels (oil separator and dry) are vented back to the gasholder, or generator which eliminates the loss of gas to the atmosphere when disconnecting the cylinders from the fill points. This is controlled by the plant process control system. A small amount of residual acetylene is vented on disconnection of the hoses, and it is not practical or economic to recover this (between the valve close and no return valve).

Lime pit emissions are insignificant when the generator is working in good condition between 70°C and 85°C and thus no abatement is necessary. This is because the ammonia, hydrogen sulphide, phosphine will tend to remain in solution, unless the pH of the lime is significantly changed, and these are therefore not emitted to air but recycled with the return water or sent off site as an impurity of the lime by-product. The only emissions from the lime pit are therefore small amounts of acetylene (formed from unreacted carbide) and arsine. There are no practical and cost-effective abatement measures. These emissions cannot be routed to the plant scrubbers due to the air content.

6.4 Compression

During compression, a small quantity of acetylene emission is possible. It can be reduced by regular inspection, and leak checking and maintenance of the compressor equipment.

6.5 Calcium carbide dust

Disposal of pure dust directly in to water in the lime pit is extremely hazardous and has been known to cause explosions. Carbide dust should be disposed of by spreading it thinly on an open surface and allow it to air slake (react with moisture in the air). Alternatively, it may be hosed down with copious amounts of water. The residues shall be drained into the lime pit.

One acceptable method to remove the dust from the container is to wash it out with sufficient water and to leave the container open for some days to vent with air. This water shall be disposed of to the lime pit. Before the container is sent for disposal it should be checked that no acetylene is left in it. The container may then be reused or recycled as scrap metal.

Returnable, reusable containers can be used which reduces the need for cleaning and disposal and this is considered the BAT.

6.6 Cylinder filling

Acetylene is dissolved under pressure in cylinders, which contain proved porous mass and a solvent that is either acetone or DMF (dimethylformamide). During cylinder filling no significant emission of acetylene or solvent occurs as it’s in a closed system. For safety reasons, every cylinder is weighed after filling to ensure that it is correctly filled. If overfilled, the acetylene can be partially emptied to gasholder or generator.

7. Noise abatement technology

The main sources of external noise at an acetylene site are:

- manual handling, use of vehicles;

- compressors and pumps; and
- operation calcium carbide loading for certain generators.

EIGA Doc 85 *Noise Management for the Industrial Gases Industry* [10] gives a comprehensive review of noise management and the actions which should be considered.

8. Energy efficiency

Using a filter press or a centrifuge to remove excess water can reduce the volume of lime, which makes transport easier and more economical.

Wet purification by acid washing represents the BAT as it removes the need for the solid purification material (hazardous solid waste) and can be fully and safely neutralised. In addition, this process is more energy efficient, as it has no regeneration operation, as with the dry purification. There is less pressure drop through the process and it avoids air emissions during the purification step.

Energy audits can be carried out (see EIGA Environmental Newsletter ENL 25 *Energy Efficiency* [11]) and, for example, more energy efficient equipment (pumps, compressors) may be installed. Energy use is not a major environmental impact for an acetylene plant.

9. Emissions to water

The acetylene plant area drainage system containment area should be sealed off from the plant drainage by a valve that is permanently locked closed. Run-off water from the acetylene plant is collected in the sump and can then be tested for pH before discharge to sewer.

Process water is recovered re- circulated, reused, or shipped off site as part of the lime product which eliminates the need to discharge process water and represents the BAT. Decanted lime water shall not be used as cooling water (for compressor, cylinders cooling etc.) because it contains impurities.

9.1 Solvents

Acetone or DMF (Dimethylformamide) shall be stored in storage tanks that are regularly inspected and maintained by qualified personnel. Where possible install vapour recovery for loading / unloading and minimise any venting operations.

The solvent storage is designed to avoid soil pollution (underground and above ground storage).

9.2 Lime

Lime storage and loading areas shall always be watertight (basins, tanks, silos etc.) to avoid soil and groundwater contamination. Additionally, they shall be open to the atmosphere to avoid the hazard of generation of explosive air / acetylene mixtures.

9.3 Ethanol / glycol

Water containing ethanol or glycol shall comply with local authority requirements before drainage into the sewage water system.

9.4 Storage tanks

Storage tanks should be designed to be fit for purpose to the appropriate national or international standard and shall be regularly inspected and maintained by competent personnel.

Large storage tanks are frequently used for fuel while the smaller ones may contain oil, antifreeze and other substances. Tanks shall be labelled. It is important to avoid spills; tanks shall be provided with secondary containment to 110% of the tank maximum contents and spill kits shall be available.

Underground storage tanks should be avoided on new facilities and the more details can be found in the EIGA Doc 106 *Environmental issues guide* [12].

Above ground storage tanks also risk contamination of soil and water if the tank starts to leak although the control of tank leakage is less complicated than for underground tanks. A dripping valve could easily contaminate several cubic meters of soil. Spill plates should be used.

When filling a tank, the operator shall attend the filling at all times. By installing overfill alarms, the risk of major spills can be further reduced. Minor spills can occur when filling or emptying the tank and precautions, such as using spill plates over drains, should be made to avoid any environmental damage.

Earthing connections should be provided for the acetone storage to prevent the risk of static electricity.

10. Other waste aspects

10.1 Calcium carbide residuals / waste

10.1.1 Description

Calcium carbide residuals normally contain small quantities of non-reactive materials for example stones, iron, ferrosilicon, coke, etc. which are infused with lime. Carbide should be purchased in consistent quality to reduce impurities. Difficulties in disposal of calcium carbide residuals arise from the lime. Due to the alkaline properties of lime it may not be possible to dispose of calcium carbide residuals on landfills without special treatment. This is due to the very high values of pH and conductivity of the residual water mixture.

To dispose of calcium carbide residuals on a landfill, permission from the competent authority may be necessary. Alternatively, the material can be used for road and parking place construction by mixing it into the concrete and thus encouraging recycling.

10.1.2 Achieved environmental benefits

Waste management reduces waste quantities, and the release of pollutants into the environment.

10.1.3 Cross-media effects

Depending on the waste disposal method applied, cross-media may require evaluation.

10.1.4 Operational data

The principle of all waste management is to avoid when possible and to minimise the generation of wastes. Hence, appropriate process design and recovery of lime to a by-product is essential for the reduction of waste.

10.1.5 Economics

Two products are produced instead of one, reducing waste handling cost.

10.1.6 Driving force for implementation

This technique will reduce the solid waste going to landfill.

10.2 Calcium carbide drums

Returnable drums and barrels should preferably be sent back without the tops refitted. If, however the top is replaced, great care is needed to ensure that no acetylene is present or can be generated. Non-returnable drums will have a scrap value and should be recycled as scrap metals.

10.3 Generator cleaning residuals waste

The generator may be cleaned mechanically or by using acids. Solid residuals of mechanical cleaning consist of slaked lime and can be disposed of in the lime pits. If acids are used for cleaning the spent mixture shall be disposed of by an authorised waste disposal contractor or can be neutralised in the lime pits under the same circumstances as spent sulphuric acid (see 10.4).

10.4 Sulphuric acid

Spent sulphuric acid shall never be drained into the sewage water system. Sulphuric acid should either be:

- returned to the producer of sulphuric acid for purification and reuse;
- neutralised in the lime pits; or
- disposed of by a specialist.

When neutralising the acid with lime the following shall be considered:

- This activity shall be included in the site regulatory permit (IED/IPPC).
- Only small amounts of acid should be neutralised in large amounts of lime to avoid emissions of hydrogen-sulphide and phosphine and to prevent foaming in the generator when water from the lime pits is reused for acetylene generation.
- The sulphuric acid shall be fed into the lime such that both substances are mixed instantaneously, for example into the lime pipe between the generator and the lime pit, or underneath the surface of the lime in the pits. The neutralisation in the lime pipe, between the generators and the lime pit, is possible only when the generators are in use.
- The wet purification process is monitored by acetylene temperature at the inlet (10 °C to 15 °C) and outlet (less than 40 °C) to prevent the risk of polymerisation which avoids additional maintenance activities and waste generation.
- The benefits are in reduced disposal cost and on-site treatment removes the need for transporting hazardous waste off site for treatment.

10.5 Sodium hydroxide (NaOH) and sodium carbonate (Na_2CO_3)

The sodium hydroxide and sodium carbonate concentration can be diluted in the lime pits, provided this activity is included in the site regulatory permit. The concentration of these materials shall be kept low.

10.6 Purifier materials

Sulphuric acid and sodium hydroxide shall be stored in dedicated containers on an impervious surface with secondary containment. Dry purifiers contain ferric/ferrous chloride and traces of mercury. The spent chemicals require disposing of by an approved contractor.

10.7 Silica gel / alumina gel

Used gel should be checked for oil contamination. Uncontaminated gel can be disposed of as non-hazardous waste. Consideration should be given to return it to the supplier.

10.8 Calcium chloride

The normal way to dispose of the calcium chloride is to dilute it with the lime sludge in the lime pits, but when the lime is delivered to a water treatment plant the calcium chloride shall be diluted to a level of

the chlorine ion concentration that does not adversely affect the functioning of the water treatment plant. The maximum level shall be agreed upon with the treatment plant operator.

In general, the calcium chloride is eliminated as condensate during the purging of the low pressure drier and high pressure drier. Both drains are collected by water trap, and the condensate shall be managed according to local laws.

A back pressure valve installed and set at 14 bar at outlet of high pressure dryer will help to improve acetylene drying which avoids damage to the porous mass

10.9 Packing materials

Packing materials (Raschig rings, Berl saddles, etc.) should be rinsed, where practicable, with suitable cleaning agent before being reused or disposed of on a normal landfill. The cleaning agents should be disposed of according to their properties and in accordance with this publication.

In all cases, the recommendation of the manufacturer about good practices on these packing materials shall be applied

10.10 Cylinder maintenance

10.10.1 Scrap cylinders – waste

Scrapped acetylene cylinders, porous mass and acetone / DMF should be treated in accordance with EIGA Doc 05 *Guidelines for the management of waste acetylene cylinders* [13].

10.10.2 General

Any material containing oil, oil binders and oily cloths should be disposed of as hazardous waste in accordance with local regulations, for example burning in an incinerator plant or deposition on a licensed landfill site.

Valves, membranes, metallic packing materials, flame arrestors etc. should be handled as scrap metals.

11. Environmental management systems

11.1 Description

The essential elements of an environmental management system are described in many sources.

A summary for the industrial gases industry is found in EIGA Doc 107 *Guidelines on Environmental Management System* [14], which provides a guide to implementation of an environmental management system according to EN ISO 14001 *Environmental Management System* [15] into the existing quality system according to EN ISO 9001*Quality Management System* [16].

EIGA Doc 109 [4] identifies specific important environmental aspects and impacts to be identified and managed in operation and guidelines for so doing, including:

- energy management (ISO 50001 Energy Management Systems [17]);
- noise;
- emissions to air and water;
- consumption of calcium carbide and water consumption;
- use and management of lime and calcium carbide residuals; and

- use of consumables such as lubricants, acetone, sulphuric acid, compressed air, other utilities, adsorbent materials.

Additional guidance is provided in EIGA Doc 88 *Best Environmental Management Practices* [18].

11.2 Achieved environmental benefits

The overall effective management of the installation minimises environmental and other impacts.

11.3 Emergency plan

The main hazards of acetylene are

- the extremely high flammability;
- the possibility to form explosive mixtures with air in a wide range; and
- its property of decomposition under various circumstances with the consequence of a fire or an explosion.

To prevent such an event all acetylene plants shall be equipped with an emergency shut down system to stop all electrical machinery. An emergency water deluge system shall also be provided to cover the cylinder filling and indoor storage areas. Water deluge systems shall be designed to avoid oil and chemical storage areas so that their operation does not spread contamination. They shall not be installed over the generators or in the carbide storage areas, and area of carbide transfer. Their purpose is to cool hot cylinders in the event of a fire or internal decomposition.

The gas company employees and contractors shall be aware of the site emergency plans, trained and competent in the requirements. The emergency plan should contain:

- actions in the event of the emergency shut down system activating;
- actions in the event of environmental events such as major leakage of lime, chemicals or oil in the emergency plan;
- the location of absorption material to clean up spills on the floor / ground;
- actions in the event of a major gas leak;
- actions in the event of fire in the carbide store, the generator, the compressors and filling plant, the solvent bulk storage area and the cylinder storage areas;
- actions to contain contaminated fire water run-off;
- action in the event of dispersal of hazardous materials such as asbestos; and
- action in the event of severe weather and other natural causes.

The emergency plan should be regularly tested with drills, simulations etc. and periodically carry out drills with the local fire department.

12. Training documents

EIGA has a Training Package TP 03 *Acetylene Plants Environmental issues* [19], available to EIGA members.

13. References

[1] *Best Available Techniques (BAT) Reference*, European Commission Joint Research Centre. www.eippcb.jrc.ec.europa.eu.

[2] Directive 2010/75/EU*, Industrial Emissions Direction,* www.ec.europa.eu.

[3] EIGA Doc 123, *Code of Practice – Acetylene,* www.eiga.eu.

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

[5] EIGA Doc 143, *Guide to Carbide Lime Applications,* www.eiga.eu.

[6] *Communication from the Commission to the Council and the European Parliament on the Interpretative Communication on waste and by-products*, European Commission, COM 2007/0059, www.eu-lex.europa.eu.

[7] Decision 2000/532/EC*, Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste*. www.eu-lex.europa.eu.

[8] *Lime for Environmental Uses*, ASTM Special Technical Publication STP 931. www.astm.org.

[9] EIGA Doc 84, *Calculation of Air Emissions from an Acetylene Plant,* www.eiga.eu.

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