



CODE OF PRACTICE ACETYLENE

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Prepared by WG-12, Acetylene

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Amendments to 123/21

The previous publication had become very large and for the review of it, it will be split in separate publications on different topics. Step by step parts will be taken out, reviewed and published separately. The final review of this document will be done once all other sub publications are finalised.

Section	Change
8 and 10	Parts of the former content have been removed from this publication and moved to new documents: <i>EIGA Doc 237 Safe Operation of Acetylene Generator Systems</i> <i>EIGA Doc 239 Mechanical Integrity of Acetylene Generator Systems in Acetylene Plants</i> <i>EIGA Doc 240 Commodity Specification Acetylene</i> <i>EIGA Doc 241 Purification, Compression and Drying of Acetylene</i>
10	Parts of the former content have been removed from this publication and moved to new documents: <i>EIGA Doc 241 Purification, Compression and Drying of Acetylene</i>
11.4	Update of the calculation formulas; examples of calculation are moved to new design documents
13	Change of title

1 Introduction

This document has been prepared by the European Industrial Gases Association (EIGA) to give guidance for the safety requirements in acetylene production, operations filling and handling.

The previous publication had become very large and for the review of it, it will be split in separate publications on different topics. Step by step parts will be taken out, reviewed and published separately. The final review of this document will be done once all other sub publications are finalised.

2 Scope

The document covers the basic requirements for the safe and correct design and maintenance of an acetylene plant as well as customer installations.

The document also includes recommendations for the safe supply, storage, transport and use of acetylene cylinders, bundles and trailers.

The document does not relate to any particular design or construction of an acetylene plant. The document is not intended to replace manufacturers and company instructions but should be used in conjunction with such instructions.

An existing plant that is not in strict compliance with the provisions of this Code of Practice may continue to operate provided that it does not constitute an unacceptable risk to life, health or adjoining property.

3 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 and Need not

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 Acetylene compressor

comprises all components of the installation, from the suction tubes of the first compression stage to the backflow tubes placed behind the last stage of the compressor including the safety equipment and other accessories required for the operation of the compressor.

3.2.2 Acetylene cylinder bundle

Transportable unit consisting of two cylinders up to usually not more than 16 cylinders permanently manifolded together and contained within a rigid frame equipped with all necessary equipment for filling and use.

3.2.3 Acetylene dryer

Equipment for decreasing the water vapour content of acetylene

3.2.4 Acetylene filling plant

Plant in which acetylene is filled into acetylene cylinders, bundles or trailers, (battery vehicle).

3.2.5 Acetylene gasholder

Device for storing the acetylene produced before cylinder filling.

3.2.6 Acetylene generator

Equipment in which acetylene is generated from the reaction of calcium carbide with water.

3.2.7 Acetylene heat exchanger or cooler

Equipment where the temperature of the passing acetylene is intentionally decreased or increased.

3.2.8 Acetylene purifier

Equipment for reducing impurities of acetylene

3.2.9 Acetylene system

Any equipment instrument, device from the cylinder valve or bundle outlet connection to the use point.

3.2.10 Automatic quick acting shutoff device

Self-acting device which closes quickly, for example when triggered by acetylene decomposition.

3.2.11 Battery system

System of two or more cylinders connected on the high-pressure side for collective withdrawal.

3.2.12 Battery vehicle

Assembly of cylinders or bundles connected to a manifold and securely attached to a vehicle chassis such that the assembly is transported and emptied as a single unit and can be filled as a single unit.

3.2.13 Calcium carbide briquette

Compressed block of calcium carbide dust.

3.2.14 Calcium carbide containers

Vessels normally made of sheet steel with a rectangular or cylindrical shape. They are watertight and are handled either by fork lift or crane. The containers can be classified into:

- intermediate bulk container (IBC) with a capacity up to 3 m³ or 2,5 t
- other containers up to 22m³ or 20 t

3.2.15 Calcium carbide drums

Vessels manufactured from sheet steel with a capacity up to 400 kg but usually not exceeding 110 kg. They are water-tight and, depending on the design, drums can be used for one or multiple trips. Larger drums are sometimes referred to as barrels.

3.2.16 Calcium carbide dust

Calcium carbide that passes through a test sieve having a mesh width of 1 mm.

3.2.17 Calcium carbide flow bin

Bulk container (approximately 1.5 t) which is filled from the top and emptied from the bottom.

3.2.18 Calcium carbide (oversize)

Calcium carbide retained on coarser sieves.

3.2.19 Calcium carbide (undersize)

Calcium carbide that passes through the finer sieves. Any needle like pieces remaining after the sieving operation are to be counted as part of the next finer size provided that they can be pushed through the holes by hand.

3.2.20 Calcium carbide transport containers (capacity 20 t)

Containers that are used only for the transport of calcium carbide.

NOTE The calcium carbide is transferred to a charging skip or charging container. The 20 t containers have ventilation systems with drying absorbents and connections for purge and analysis or are under a light pressurization with nitrogen (e.g. 50 mbarg)

3.2.21 Calcium carbide turn bin

Bulk container (approximately 1.5 t) that has only one opening at the base that is used for filling and emptying. The bin is turned at the carbide manufacturers to enable it to be filled.

3.2.22 Deflagration

Explosion propagating at subsonic velocity.

3.2.23 Detonation

Explosion propagating at supersonic velocity and characterised by a shock wave.

3.2.24 Distributed system

Acetylene system with fixed or permanent piping.

3.2.25 Explosion

Abrupt oxidation or decomposition reaction producing an increase in temperature, pressure, or in both simultaneously.

3.2.26 Flame arrestor

Device that quenches a flame front.

3.2.27 Flashback arrestor

Device to stop a flame front and the flow of gas in the case of acetylene decomposition. This device can be activated either by a pressure shock wave or by a temperature sensing device. This is also known as decomposition blocker, see EN ISO 14114, *Gas welding equipment – Acetylene manifold systems for welding, cutting and allied processes – General requirements* [1]¹.

3.2.28 Grain size

Defines the dimension of the calcium carbide pieces. The specification for the grain size of calcium carbide will depend upon the requirements of the generator system. Example: “25/40” means the size of carbide which passes the 40mm sieve (but not the 25mm sieve) in the carbide packaging.

3.2.29 Hot spots

Locally overheated (glowing) areas of calcium carbide. These can be identified by hot surfaces on the calcium carbide vessels and generator system

3.2.30 Lime

Carbide lime or ‘carbide lime slurry’ is a suspension of calcium hydroxide in water produced when water is added to calcium carbide to make acetylene. Carbide lime is also referred to as carbide slurry, carbide sludge generator slurry, lime slurry, lime sludge, lime hydrate, lime water, or activated lime

3.2.31 Localized system

Acetylene system without fixed or permanent piping, normally being just a flexible hose, for example a torch.

3.2.32 Manifold system

System of two or more cylinders connected on the high-pressure side for collective withdrawal (see also battery system).

3.2.33 Pressure range

Acetylene plants are divided into one of the following pressure ranges:

- Low pressure. Pressure not exceeding 0.2 bar
- Medium pressure. Pressure greater than 0.2 bar but not exceeding 1.5 bar
- High Pressure. Pressure greater than 1.5 bar but not exceeding 25 bar

3.2.34 Pressure units

This document uses “bar” as the unit of pressure, and if not stated otherwise, the pressure is stated as bar gauge.

3.2.35 Residual gas

- For Tare A or Tare F: The total amount of acetylene in a cylinder returned

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

- For Tare S: The total amount of acetylene in a cylinder returned minus the saturation gas

3.2.36 Saturation gas

The amount of acetylene required to saturate the solvent at atmospheric pressure and 15 °C (refer to EN ISO 3807, *Cylinders for acetylene — Basic requirements and type testing* [2]).

3.2.37 Solvent replenishment.

Procedure for filling solvent into an acetylene cylinder up to the specified solvent content.

3.2.38 Tare A

Sum of the empty weight of the cylinder shell, the weight of the porous mass, the specified weight of the solvent content, the weight of the valve and the weight of all other parts that are permanently attached (e.g. clamps, guards, or nut bolt fixing) to the cylinder before it is filled.

3.2.39 Tare BA_{max}

Sum of the Tare A weights of all cylinders manifolded together in a bundle containing the maximum weight of solvent including the amount of positive solvent operating range plus the weight of the rigid frame and the weight of all equipment.

3.2.40 Tare BA_{min}

Sum of the Tare A weights of all cylinders manifolded together in a bundle containing the maximum weight of solvent including the amount of negative solvent operating range plus the weight of the rigid frame and the weight of all equipment.

3.2.41 Tare BS_{max}

Sum of the Tare S weights of all cylinders manifolded together in a bundle containing the maximum weight of solvent including the amount of positive solvent operating range plus the weight of the rigid frame and the weight of all equipment.

3.2.42 Tare BS_{min}

Sum of the Tare S weights of all cylinders manifolded together in a bundle containing the maximum weight of solvent including the amount of negative solvent operating range plus the weight of the rigid frame and the weight of all equipment.

3.2.43 Tare BF

Sum of the Tare F weights of all cylinders manifolded in a bundle, plus the weight of the rigid frame and the weight of all the equipment.

3.2.44 Tare F

Tare A minus the weight of the solvent.

3.2.45 Tare S

Tare A plus the weight of the saturation gas.

3.2.46 Yield

Number of litres of crude acetylene obtained from a 1 kg sample. The yield is determined in l/kg and is corrected to 15°C and 1013 mbar moist, that is saturated at 15°C with water vapour.

4 General

4.1 Training of personnel

All personnel involved in acetylene operations shall be fully trained in both the theory and practice of acetylene and also assessed for competency in the following as required:

- The general requirements of this Code of Practice.
- Properties of all gases, chemicals and impurities involved in the production of acetylene.
- Operation of the relevant part of the acetylene process.
- Emergency procedures and equipment.
- Personal Protective Equipment (PPE) requirements, including gloves, goggles, safety shoes and other protective equipment.
- Acetylene cylinder properties and characteristics.

Persons undergoing training shall be supervised by a competent person(s) when working in an acetylene plant. Further details can be found in EIGA Doc 23, *Safety Training of Employees* [3].

4.2 Management of change

Acetylene plants shall be designed and constructed to the appropriate acetylene plant engineering standards. Changes to the plant or process can introduce serious hazards if not carried out in a controlled manner.

Any changes to the plant or the operational procedures shall be approved and validated by a competent person using formal change management procedures. Such procedures shall include validation of any changes to the plant or process using techniques such as HAZOP (Hazard and Operability Study), Risk Assessment, FMEA (Failure Mode Effects Analysis) as appropriate. Further details can be found in EIGA Doc 51, *Management of change* [4].

5 Acetylene properties

5.1 Physical and chemical properties

Acetylene is a compound of the elements carbon and hydrogen, its composition being expressed by the chemical symbol, C_2H_2 . On a weight basis, the proportion of the elements in acetylene is about twelve parts of carbon to one part of hydrogen, or 92,3 % to 7,7 %, respectively. At atmospheric temperatures and pressures, acetylene is a colourless gas, which is slightly lighter than air. Pure acetylene is odourless, but acetylene of ordinary commercial purity has a distinctive, garlic-like smell. Some physical constants of acetylene are given in Table 1.

Acetylene burns in air with an intensely hot, luminous and smoky flame. The ignition temperatures of acetylene, mixtures of acetylene and air, and mixtures of acetylene with oxygen will vary according to composition, pressure, water vapour content and initial temperature. As a typical example, mixtures containing 30 % acetylene by volume with air at atmospheric pressure can auto ignite at about 305 °C. The flammable limits of mixtures of acetylene with air and acetylene with oxygen will depend on the initial pressure, temperature and water vapour content. In air at atmospheric pressure, the upper limit of flammability is about 82 % acetylene and the lower limit is about 2.3 % acetylene.

Acetylene can be liquefied and solidified with relative ease and both phases are unstable. Mixtures of gaseous acetylene with air or oxygen in certain proportions can explode if ignited. Gaseous acetylene

under pressure without the presence of air or oxygen can decompose with explosive force. This can also occur at low pressure under certain conditions.

5.2 Physiobiological

Pure acetylene is classified as non-toxic but is an asphyxiant gas with slight anaesthetic properties. Pure acetylene has been shown in experiments to have no chronic harmful effects even in high concentrations. Unpurified acetylene generated from calcium carbide contains phosphine in concentrations of typically 300-500 ppm, which is toxic. Poor quality calcium carbide can generate phosphine concentrations in excess of 1000 ppm. Therefore, exposure to personnel shall be monitored and controlled. Acetylene is a simple asphyxiant if present in such high concentrations that the lungs are deprived of their required supply of oxygen. In such cases, asphyxiation will result. It should be noted however, that the lower flammable limit of acetylene in air will be reached well before asphyxiation occurs, and that the danger of fire or explosion is reached before any other health hazard is present.

5.3 Tables of acetylene properties

Table 1: Physical properties of acetylene

Chemical formula	C ₂ H ₂	
Molecular weight	26,04	g/mol
Specific mass (0 °C, 1,013 bar)	1,172	kg/m ³
Relative mass (air = 1)	0,908	
Critical temperature	35,2	°C
Critical pressure	61,9	bar(a)
Critical density	231	kg/m ³
Temperature at triple point	-80,6	°C
Pressure at triple point	1,282	bar(a)
Sublimation point (1,013 bar)	-83,8	°C
Vapour pressure of the liquid (0 °C)	26,7	bar(a)
Viscosity (0°C)	95	μPa*s
Specific heat at constant pressure (0 °C, 1,013 bar)	1637	J/(kg*K)
Specific heat at constant volume (0 °C, 1,013 bar)	1309	J/(kg*K)
Thermal conductivity (0 °C, 1,013 bar)	18,4	kJ/(s*m*K)
Heat of formation ΔH _f [°] (25 °C, 1,013 bar)	227,4	kJ/mol
Heat of combustion ΔH _c [°] (25 °C, 1,013 bar)	1301,1	kJ/mol
Flammability limits (in air) (see note 1)	2,3 –82*	% by volume
Flammability limits (in oxygen) (see note 1)	1,5 - 93*	% by volume
Minimum ignition energy in air	0,019	MJ
Auto ignition temperature in air	305	°C
Auto ignition temperature in oxygen	296	°C
Stability pressure	0,8	bar

NOTE 1 These figures are theoretical as they only refer to the reaction of acetylene with oxygen. The upper explosive limit for acetylene is effectively 100% due to its inherent instability.

NOTE 2 Physical data from Air Liquide gas encyclopaedia

Table 2: Solubility of acetylene in water in g/kg

Temp. in °C	Acetylene partial pressure in bar(a)						
	1,013	5,065	10,13	15,195	20,26	25,325	30,39
1	1,97	9,43	Acetylene hydrate tends to form				
10	1,56	7,40	14,2	20,3	Acetylene hydrate tends to form		
20	1,23	5,82	11,4	16,6	21,2	25,0	28,7
30	1,01	4,70	9,5	14,0	17,9	21,5	25,0

Table 3: Solubility of acetylene in acetone in g/kg (reference: Miller [5])

Temp. in °C	Acetylene partial pressure in bar(a)								
	1,013	2,026	3,039	5,065	10,13	15,195	20,26	25,325	30,39
0	58,0	109,5	158	241	526	912			
5	48,7	95,3	137	208	447	754	1157		
10	41,1	83,0	122	182	384	636	958		
15	34,0	72,0	107,2	161	335	546	811	1146	
20	27,9	62,4	94,2	142,3	293	472	689	960	1297
25	22,4	53,5	82,2	126,6	259	413	597	822	1099
30	17,9	45,7	72,1	113,0	230	364	521	710	940
40	10,4	33,0	54,0	92,5	185	289	408	546	709
50		22,7	41,2	75,2	150,5	234	327	432	554

Table 4: Solubility of acetylene in DMF (dimethylformamide) in g/kg (Reference: Miller [5])

Temp. in °C	Acetylene partial pressure in bar(a)						
	1,013	5,065	10,13	15,195	20,26	25,325	30,39
0	77,3	258	521	736			
5	66,6	224	447	649			
10	57,3	196	391	582	728		
15	49,5	173	341	509	653	742	
20	42,7	154	301	452	593	702	
25	37,2	138	269	404	536	654	739
30	32,3	125	241	362	485	602	701
40	24,4	103	197	295	398	504	607
50	18,8	86	164	245	331	421	514

5.4 Acetylene decomposition

Acetylene decomposition is the spontaneous reaction to elemental carbon and hydrogen. This can occur at low or medium pressure as either a deflagration at a relatively slow reaction rate, or as a detonation at supersonic velocity.

Deflagration produces final reaction pressures ten to eleven times initial pressure from the energy released by the reaction. Detonation of high-pressure acetylene can produce pressure peaks up to fifty times the original pressure. Detonation pressure peaks are short lived but shall be considered in designing a safe high-pressure acetylene system. Conventional pressure relief devices offer no protection as detonations proceed at supersonic velocity and they cannot react with sufficient speed.

NOTE Decomposition temperature depends on different conditions and operating parameters. For example, temperature and moisture content of the gas, internal pipe surface corrosion, contaminants, and flow rate.

5.5 Polymerisation

Acetylene is capable of reacting with other acetylene molecules to form larger hydrocarbon molecules, for example benzene. This process is known as polymerisation and heat is required to initiate the reaction.

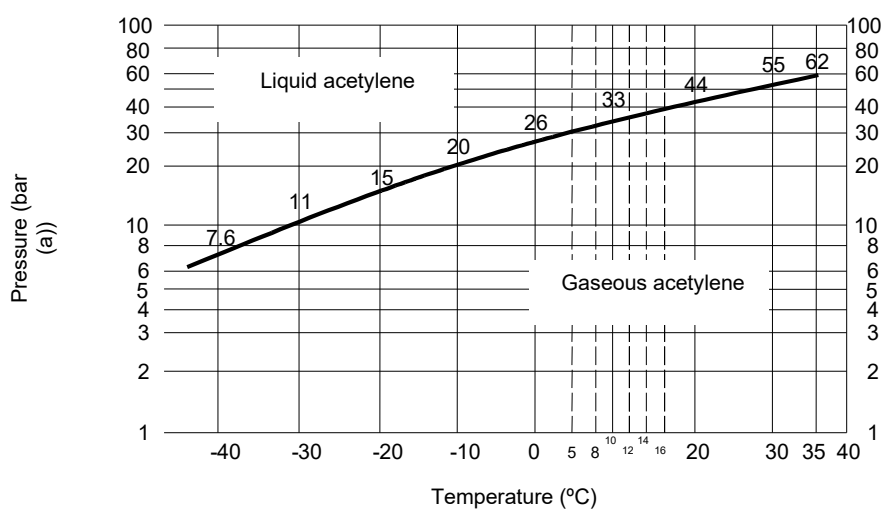
Once the process is started, heat is liberated and the reaction becomes self-sustaining above atmospheric pressure; this can lead to an explosive decomposition of acetylene into its elements, carbon and hydrogen.

Polymerisation readily commences at 400°C and at atmospheric pressure and can occur at lower temperatures in the presence of catalysts such as pipe scale, rust, silica gel, diatomite (kieselguhr), charcoal.

5.6 Liquid acetylene

Liquefied acetylene has a high explosive potential and has higher shock sensitivity and energy density than compressed gaseous acetylene. Thus, the liquefaction of acetylene shall be absolutely avoided in acetylene charging operations. Figure 1 presents the vapour pressure curve for acetylene. Note that at low temperature operations, acetylene could liquefy.

Figure 1: Liquid acetylene formation

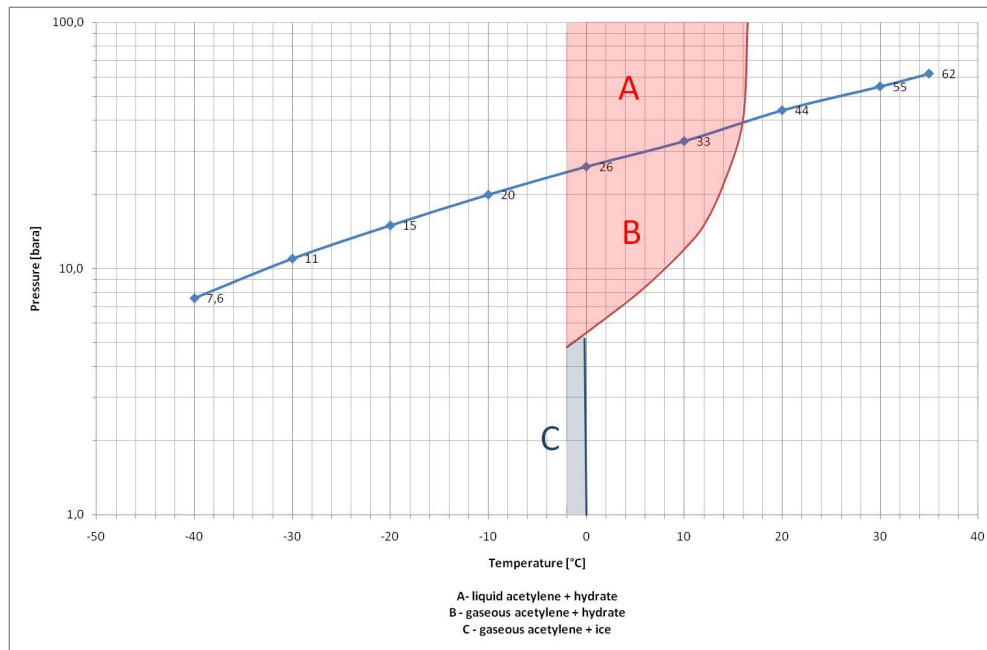


5.7 Acetylene hydrate

The formation of acetylene hydrates $C_2H_2 \cdot 5,75 H_2O$ as an acetylene compound shall be considered in the acetylene process. Acetylene hydrate is not as dangerous as liquid acetylene, but it may decompose. Solid acetylene hydrate can cause blockages in acetylene piping, valves, flashback arrestors and other components.

When wet acetylene cools under increasing pressure, acetylene hydrate can be formed. Acetylene hydrate formation conditions are shown in Figure 2.

Figure 2: Acetylene hydrate formation



To minimise the risk of hydrate formation, the following precautions shall be taken

- Avoiding working with wet acetylene at high pressure.
- Keeping the acetylene pressure and temperature conditions to the right and out of cross-hatched areas in the graph above.
- Minimising rough surfaces that can encourage formation of hydrates and create blockages in restricted passages.

5.8 Acetylides

When acetylene comes into contact with copper, silver, mercury or salts of these metals, explosive acetylides can form. These acetylides are highly sensitive to shock or friction.

See 6.2 regarding materials of construction for further details.

5.9 Adiabatic compression

Adiabatic compression of gases results in a temperature rise that could be sufficient to initiate acetylene decomposition.

Decomposition in acetylene pipework and hoses arising from adiabatic compression of acetylene shall be considered during the design of an acetylene installation. There have been a number of incidents where adiabatic compression has caused decomposition in acetylene pipework and hoses.

The presence of nitrogen or air in acetylene pipework and hoses will increase the risk of a decomposition occurring under adiabatic compression conditions. This is due to the higher adiabatic compression temperature of nitrogen.

Based on the above, the following shall be considered:

- Prevent the ingress of air into pipework and hoses carrying high-pressure acetylene for example, when connecting cylinders to a manifold. The use of non-return valves on filling hoses and by purging will reduce the possibility of air ingress and consequently reduce the possibility of adiabatic ignition.
- Use safety devices such as a flashback arrestor with a cut-off device to prevent the transmission of decomposition through the system.

6 Acetylene system components

6.1 Design consideration

Acetylene production and filling plants shall be designed, constructed and operated to standards and procedures to ensure the maximum integrity of the equipment and safety for personnel. Design and construction of plant and equipment shall be in accordance with all applicable European Directives, including the *Machinery Directive* 2006/42/EC, the *Pressure Equipment Directive* (PED) 2014/68/EU and the *Equipment for explosive atmospheres (ATEX) Directive* 2014/34/EU [6, 7, 8].

Safety devices shall be provided on the system to ensure that parameters such as pressures, temperatures, and flow levels are kept within safe limits at all times.

The equipment shall be designed, equipped, operated and maintained to ensure that during normal conditions of operation:

- Air or oxygen cannot enter the system and shall never exceed 50% of the lower flammability limit in acetylene containing parts.
- Air or acetylene can be eliminated from the system by purging with an inert gas such as nitrogen for maintenance tasks.
- An excessive rise of pressure and temperature can be prevented.

6.2 Materials of construction

Materials of construction shall withstand the mechanical and thermal conditions that can occur during normal operation and under anticipated upset conditions. Materials of constructions shall be chemically compatible with the processes involved in acetylene production. The materials should not cause adverse reactions with acetylene, solvents, carbide and other products generated from carbide.

Because acetylene can form explosive compounds with copper, silver and mercury, these metals are prohibited in the construction and maintenance of acetylene systems. Some alloys containing restricted amounts of these metals may be used.

Steel is the preferred material for the construction of acetylene system components.

Plastic materials and man-made fibres shall not be used in an acetylene plant for tools or equipment unless it has been demonstrated that the risk for electrostatic charging is eliminated, for example brooms and buckets.

Materials used in packing, sealing and membranes shall be resistant against acetone or other solvents used. For additional information refer to EIGA Doc 225, *Solvents for Acetylene Filling* [9]

Table 5 provides information on prohibited or restricted compatibility materials for acetylene applications:

Table 5: Materials not allowed or recommended only under certain conditions

Material	Conditions for use
Copper and copper alloys containing more than 70% copper *	Not allowed.
Alloys containing up to 70% Copper*	Permitted. Consideration should be given to the use of copper alloys for filters, sieves etc. that have a large surface area in contact with acetylene and also for parts in contact with moist unpurified acetylene. Any heat process which produces copper enrichment on the surface of the copper alloy shall be avoided. NOTE ADR and EN ISO 11114-1 Gas cylinders – Compatibility of cylinder and valve materials with gas contents – Part 1: Metallic materials, use a figure of 65% copper for transportable equipment [10,11]
Silver and mercury	Not allowed.
Silver alloys*	Suitable for brazing, provided that the silver content does not exceed 43%, the copper content does not exceed 21% and the gap between the two parts to be brazed does not exceed 0,3 mm. Care shall be taken to minimise the area of filler metal exposed to acetylene and to remove as far as is practicable all traces of flux.
Aluminium, Zinc, Magnesium, and their alloys	Not recommended for components, which come in contact with wet acetylene contaminated with lime or ammonia (un-purified generator gas).
Zinc	Suitable as external anti-corrosion protective coating.
Glass	Should be used only for sight glasses such as U-tube manometers and similar devices. This type of device should either be protected against external damage or be designed to withstand breakage or alternatively, the system designed so that breakage will not cause a hazard.
Organic materials	May be used if they are resistant against acetylene, solvents and impurities.

NOTE Where brazing alloys containing silver and copper are not in compliance with the above Refer to EN ISO 9539, *Materials for equipment used in gas welding, cutting and allied processes* [12]

6.3 Cleaning

Degreasing is normally not required for acetylene plants. After construction works acetylene systems, particularly for high pressure shall be cleaned internally to remove any loose matter, e.g. by blowing through with compressed air.

Before initial start-up and after maintenance and service work, the system should be purged with an inert gas, usually nitrogen. The use of carbon dioxide for purging is not recommended due to the risk of static electricity generated from droplets and dry ice particles.

6.4 Valves, fittings, regulators, hoses and safety devices

6.4.1 Regulators

Regulators shall comply with EN ISO 7291, *Gas welding equipment – Pressure regulators for manifold systems used in welding, cutting and allied processes up to 300 bar* [13].

6.4.2 High pressure hoses

Hoses shall comply with EN ISO 14113, *Gas welding equipment – Rubber and plastic hoses assembled for compressed or liquefied gases up to a maximum design pressure of 450 bar* [14].

Hoses should only be used where rigid pipes are not able to be used. The length and the diameter of the hose should not be larger than necessary.

Consideration should be given to the design of the end fittings, particularly to the avoidance of sudden changes in internal diameter. Where there is a change in diameter a gradual taper should be made.

Where hoses are used in an installation the resistance between the two end-couplings should not exceed 10^6 ohms to reduce the risk of electrostatic charging. Further details can be found in EN 12115, *Rubber and thermoplastics hoses and hose assemblies for liquid or gaseous chemicals. Specification* [15].

6.4.3 Pressure relief devices

Acetylene vented from pressure relief devices should be discharged outside the building to an area specifically classified for acetylene where there is no risk of ignition. All discharge pipes or orifices to the open air shall be designed and made in such a way as to avoid choking, obstruction or frictional pressure drop. Pressure relief device discharge pipes should be separate and connection to a manifold should be avoided.

6.4.4 Flame arrestors and flashback arrestors

The location of flame arrestors and flashback arrestors depends on the type, size and operating pressure of the installation. Flame arrestors and flashback arrestors may be necessary to separate sections, which fall under different operating pressures.

All components of the flame arrestor shall resist the expected mechanical, thermal and chemical loads for their intended use.

See also 10.5

6.4.5 Pressure sensors and indicators

Pressure sensors and indicators shall be constructed with a sensing element of steel, or alloys containing less than 70 % of copper.

Pressure sensors and indicators shall be constructed with a solid bulkhead and a blow-out back or safety vent, the dial of the gauge should be marked ACETYLENE and be suitable for the maximum working pressure

Pressure sensors and indicators for medium and high working pressure shall comply with one of the following:

- be fitted with an impulse line restrictor of 0.5 mm diameter to limit the escape of gas should the pressure gauge fail and to protect the mechanism from damage due to pressure surges; or
- protected by a flame arrestor.

Pressure indicators shall be in compliance with EN 837-1, *Pressure gauges* [16].

6.4.6 Valves and pipework fittings

Cast steel flanged fittings or forged steel welding fittings are recommended for use in all pipe sizes. Screwed fittings may be used if they have been verified as being suitable for the appropriate working range.

High pressure valves should comply with the requirements of EN ISO 15615, *Gas welding equipment – Acetylene manifold systems for welding, cutting and allied processes, and safety requirements in high-pressure devices* [17].

The design of valves or the method of installation shall be such as to minimise the risk of ignition due to friction. Filters may be used to eliminate the possibility of dirt getting onto the valve seat.

Any type of seal or packing may be used provided it complies with 6.2.

6.5 Operating procedures, periodic inspection and maintenance

The appropriate tools and equipment shall be used. For example, the use of spark proof tools. The work should comply with maintenance schedules from the equipment suppliers.

The operation of a plant for the production and filling of acetylene shall only be carried out by competent persons trained and assessed in the hazards, handling and maintenance of the products and equipment. For example, when maintaining ATEX certified equipment.

Equipment shall not be taken out of service for repair until all pressure has been released and the system purged with nitrogen whenever necessary. Using carbon dioxide is not recommended due to the risk of static electricity.

When purging by dilution, the procedure used shall be validated (including, but not limited to gas flow, duration, number of cycles).

Precautions should be taken to prevent ignition and ventilation should be provided during purging operations for as long as there is a possibility of an air-acetylene mixture existing, for example, by opening windows and doors.

The atmosphere inside the equipment shall be controlled to prevent an explosive atmosphere. The atmosphere shall be tested with a gas detector suitable for measuring combustible gases (Explosimeter). Explosimeters shall be suitable for measuring acetylene in nitrogen as well as acetylene in air. E.g. pellistor type explosimeters are not able to measure acetylene in nitrogen.

Personnel shall be trained and assessed in the correct operation of such equipment.

It is recommended to continuously monitor the atmosphere while work is being undertaken.

Attempts to test for a combustible gas in an atmosphere low in oxygen can give unreliable readings.

Verify with an oxygen meter that the level of oxygen inside the equipment to be entered is within safe limits for breathing before entry.

All the equipment used to measure the atmosphere (explosimeter and oxygen detector) shall be operated, maintained and kept in working condition in accordance with the manufacturers' recommendations and requirements. Periodic inspection of this equipment shall be carried out.

The purge gases shall be vented to outside of the local working area to a safe location.

When emptying the water in acetylene carrying equipment (including the gasholder or generator) the water shall be discharged to a location (lime pit) where the dissolved acetylene can disperse rather than

it being directed into a sewer or drain whilst still saturated with acetylene. This water shall not be discharged into the sewer or town drainage system.

6.5.1 General

Periodic inspection and maintenance is required to ensure that the installation remains within the specified design parameters.

Routine inspection and maintenance of equipment shall be carried out on a planned basis and be recorded.

The production site shall be inspected to ensure that it is within the specified design parameters and that safety distances originally specified are still maintained.

An installation dossier shall be held on site; this dossier should include:

- process and instrumentation diagrams;
- pressure vessel and tank dossiers;
- operating and maintenance instructions.

Check the plant and equipment at appropriate intervals (for example daily, weekly, and annually) to verify:

- The condition of the main plant components, for example, the generator, gasholder, dryers, compressor, tanks, pressure vessels and piping and accessories.
- The operation and settings of all control loops and systems.
- All safety related operations and non-return valves for safety against backflow of gas and safety valves.
- Operation of the deluge system.
- Minor repairs, e.g. changing of seals.
- The pigtails and flexible hoses are not damaged.
- The valves open and close correctly and the system is operating within normal parameters (for example, if system is using more gas than normal, an unusual drop in pressure or smell of gas which could indicate a malfunction or leak).
- The regulators are not damaged, and they operate within their specified operating parameters.
- Piping and fittings are not corroded.

6.5.2 Pressure relief devices (PRDs)

Routine visual inspections of the PRDs shall be carried out during operation of the plant.

Pressure relief valves shall be tested to a defined schedule based on the manufacturers' recommendations, national requirements or Process Hazard Analysis whichever is the more stringent.

Whilst bursting discs are not commonly used on acetylene plants, bursting disc elements can deteriorate with time resulting in their relief pressure rating being reduced. Therefore it can be necessary to replace bursting disc elements periodically.

6.5.3 Process safety equipment

Process safety equipment, such as critical trips and alarms shall be maintained and tested to a defined schedule based on the original equipment manufacturers' recommendations, national codes or Process Hazard Analysis whichever is the more stringent.